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THE ROYAL ENGINEERS JOURNAL.

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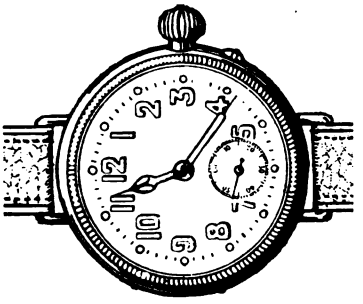

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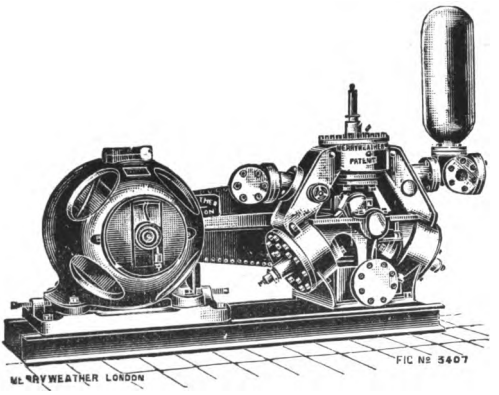

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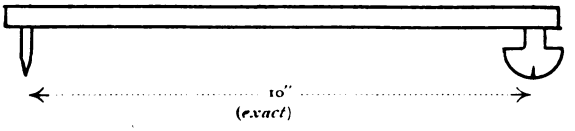
A SIMPLE PLANIMETER.

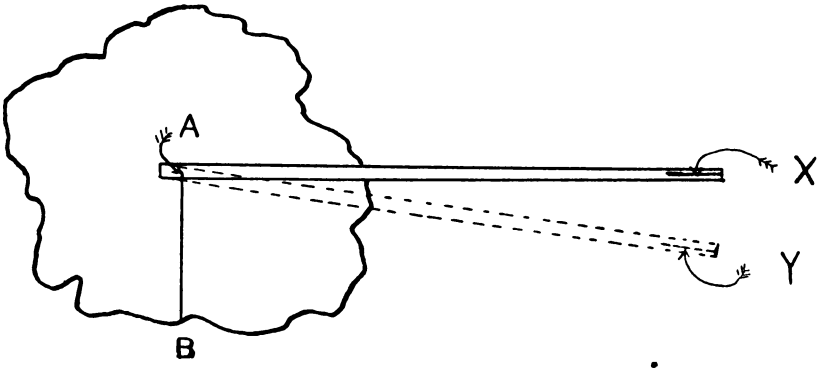
By CAPT. H. W. HERRING, R.E.

THE following is a description of a simple form of planimeter which might be of use to officers as it can readily be made with materials to hand.

The instrument consists of a pointer rigidly connected by a bar to a curved knife edge, edge and point in the same line; a nail would do for the one and the end of a table knife for the other, 10 in. between the two is a convenient length.



To ascertain the area of any irregular figure proceed as follows :—



1. Choose a point A at the approximate centre of the figure.
2. From A draw any line AB to the side of the figure.
3. Place the instrument at right angles to this line, with its pointer at A, press gently above the knife edge so that it marks the paper. Call this mark X.

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4. Holding the instrument above the pointer (leaving the knife edge free to move on the paper) move the pointer from A to B, round the figure and back to A; again press knife edge to mark paper. Call this mark Y.

Note the pointer must be kept vertical.

Then XY (in inches) × 10 = area of figure in sq. in.

The results given are not absolutely accurate but are near enough for most practical purposes.

To anyone with leanings towards mathematics the calculation of this theoretical inaccuracy may prove an interesting problem.

Others can try it on a figure of known area.

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THE MODERN DEVELOPMENT OF WATER POWER.

By ALPHONSE STEIGER, M.INST.C.E.

AT a meeting of the Society of Engineers (Incorporated) on the 6th December a paper was read by Mr. Alphonse Steiger, M.INST.C.E., in which it was stated that the modern development of water power, mainly due to the extensive use of electrical energy for a variety of purposes, has brought about a complete change in the construction of turbines and their size, turbines now being in use which give as much as 20,000 B.H.P. The total capital invested in hydraulic power undertakings is now probably over £500,000,000.

The available power in Great Britain is variously estimated at from 500,000 to 1,000,000 H.P. To develop that power by steam would require 2,410,000 tons of coal per annum, and the value of that coal at 10s. per ton would represent the interest at 5 per cent. of a capital of £24,100,000.

Water power is, to a certain extent, dependent on meteorological and topographical conditions, and a certain regularity may be obtained by afforestation and by storage, such as is provided for irrigation purposes. Schemes are now being carried out or contemplated to make large, swift rivers navigable and to afford large power plants destined to form industrial centres in the future.

Turbines are the most efficient of water motors. They are classified into impulse turbines and pressure turbines, represented by Pelton wheels and Francis turbines respectively, various types of which are described. The selection of a turbine does not depend on the fall alone, and in selecting a turbine the efficiency under varying conditions should be carefully considered, as efficiency represents capital value. The falls so far utilized range from 2 ft. up to 5,000 ft., and a Pelton wheel is described utilizing a fall of 2,800 ft.

The governing of turbines has been completely revolutionized owing to the requirements for generating electricity, and has been brought to a high state of perfection. The prompt action of the modern hydraulic governor calls for special devices for the protection of pipe lines against bursting owing to water-hammer, and an ingenious mechanism is shown whereby that danger is prevented without any waste of water.

The paper further deals with the *cost of power*. Not the capital outlay, but the annual expense of a power-generating plant should

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be the deciding factor. A comparison of the annual costs of various sources of power is given, showing that these costs are less in the case of a water-power plant, even if the capital expenditure on it has been greater than that of a steam plant of the same power. With a good load-factor a larger capital outlay for a water-power plant is admissible, and such plants with auxiliary steam power to make up for shortness of the water supply in the dry season are remunerative. An instance is mentioned where the power for a heavy day-load is supplemented by pumping water at night time to a reservoir which is used during day time.

Water power has become of such importance in recent years that a State monopoly has been considered in some countries. Some protection against injudicious use of water for one purpose to the detriment of others is necessary in order to facilitate the development of water power where it benefits the population of a district.

The purchaser of a turbine should ask for a definite guarantee of efficiency of the turbine he proposes to buy, not of the power, and, where the conditions of water supply vary, of the efficiency under a diminished water supply. The paper states how the claims should be formulated to prevent disputes or lawsuits.

In the concluding pages the method of testing turbines and the various operations necessary for testing turbines were described, and it was shown that a great difference in the results may be obtained by inaccuracy or carelessness in the measurements of water.

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SIEGES AND THE DEFENCE OF FORTIFIED PLACES BY THE BRITISH AND INDIAN ARMIES IN THE XIXth CENTURY.

(*Continued*).

By COLONEL SIR EDWARD T. THACKERAY, V.C., K.C.B. (LATE R.E.).

CAPTURE OF KABUL, 1879.

After the massacre of the Resident, Sir Louis Cavagnari, with the greater part of his escort at Kabul on September 3rd, 1879, orders were immediately issued for a new advance on that city and for the retention of Kandahar.

It was decided that the movement on Kabul should be made by the Kurum Column under the command of General Sir Frederick Roberts (afterwards Field Marshal Earl Roberts, V.C., O.M., G.C.B., G.C.S.I., etc.). General Roberts who at the time was at Simla hurried down to reassume command of the force, and reached Alikhel on the 12th September. The column which numbered about 6,000 fighting men, began the advance the following day, and after defeating the enemy at Charasiab, entered Kabul on the 8th October. The Engineers at once set to work to repair the fortifications. The Sherpur Cantonment had to be repaired, its defences improved, and its accommodation remodelled. The Chief Engineer with the force was Colonel Æneas Perkins, C.B., R.E. (afterwards General Sir Æneas Perkins, K.C.B., Colonel Commandant, R. (Bengal) E.), an officer who had greatly distinguished himself in the Indian Mutiny, in the Bhootan War, and latterly in the Kurum Valley. The advance guard of the force had reached the Shutargurden as early as the 11th September. Lieut. Nugent, R.E.,* was with this force, and he immediately began entrenching the position with the 23rd Pioneers.

The Bala Hissar had also to be made fit for occupation by troops. Among the public buildings in Kabul, the Bala Hissar or Citadel claimed the first importance, but not from its strength. Kabul is enclosed to the south and west by high rocky hills, and at the eastern extremity of these the Bala Hissar which commands the city, is situated. There was another fort under it, also called the Bala

* Lieut. Nugent was unfortunately killed while engaged in blowing up some towers near Kabul on the 23rd December, 1879, owing to a defective fuse.

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Hissar. It was a poor, irregular and dilapidated fortification. The upper fort is small, but that below will contain about 5,000 people. The Bala Hissar was built by different princes of the House of Timur, from Baber downwards. Aurungzeb prepared extensive vaults under it to defend his treasures.

A new line of communication had also to be opened out, the Shuturgurden Pass, by which the advance had been made, being blocked with snow in the winter. The new line of communication with Kabul from Peshawur by the Khyber Pass was adopted and the route by the Shuturgurden was abandoned.

The streets of Kabul City are narrow, and the houses built with flat roofs. To many of the better sort of private dwellings there were gardens. The town is situated in a gorge between two lofty hills, up and along whose steep and rocky ridges a long line of massive wall is discernible, with numerous half-ruined towers, once forming an imposing barrier of defence against the sudden and devastating inroads of the western tribes.

The largest portion of the city stands on the right bank of the river, the opposite side being principally lined with walled gardens and small forts. The covered bazaar consisted of five open squares connected by four arcades, down the centre of which a marble aqueduct conveyed a small running stream, the sides being lined with shops. The great Bazaar or Chunhut, an arcade nearly 600 ft. long, and about 30 ft. broad, was divided into four equal parts, the streets being intersected with small covered aqueducts of clear water, a great convenience to the people. Kabul was a compactly-built city, but the houses had no pretension to elegance. They were constructed of sun-dried bricks and wood, and few of them were more than two stories high. It was thickly peopled, the population being about 60,000. The Kabul River flows through the city. There could not be a dirtier place in rain.

At the period under notice signs of unrest were becoming apparent in the neighbourhood of Kabul, and by the end of the first week of December the Afghans assembled in such overwhelming numbers that General Roberts had to withdraw the outposts, and on December 14th assembled the whole of his small force within the walls of Sherpur. Entrenchments were hastily constructed to strengthen the position against the overwhelming force of the enemy. Under the direction of Colonel Perkins gun emplacements and abattis were rapidly constructed, blockhouses were built on the Bimaru Heights, walls and villages dangerously near the cantonment were blown down and levelled, and a second line of defence within the enclosure was improvised. The perimeter of the cantonment was over 4 miles, only 1½ of which were enclosed by a wall.

A scheme had been prepared by the Engineers in November for its improvement, and this was now put in hand; the northern face

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was formed by the Bimaru Heights on which some towers had been constructed. It was now further fortified by a line of breastwork with emplacements for guns at intervals. The north-west face was defended by a ditch and breastworks made with ammunition waggons, abattis, and wire entanglements. The eastern face, the weakest, was defended by detached buildings, and Bimaru Village was loopholed. Garden walls and villages dangerously near the cantonment were blown down and levelled. It was considered necessary to clear carefully 800 yards all round the cantonment enclosure.

In November a force was dispatched from Kabul under Brig.-General Macpherson (afterwards Lieut.-General Sir Herbert Macpherson, K.C.B.), to join hands with the Khyber Field Force that had advanced through the Khyber to Jellalabad and Gundamuk, under the command of Lieut.-General Bright. The two commanders met near Kota Sungh on the 6th November. General Macpherson's column then returned to Kabul, and General Gough's Brigade returned to Gundamuk. Detachments were left at the various posts between Gundamuk and Kabul, viz., Soorkhab, Jugdulluk Kotul, Jugdulluk, and Latabund.

On Monday, 8th December, 1879, General Roberts ordered a great divisional parade at Kabul. On the afternoon after the review (the village of Arghandi, a great centre of discontent on the direct road to Gharni having been selected for attack), Macpherson's Brigade moved into the Chardeh Valley and encamped at Killa. On the 9th the forces halted to allow General Baker (afterwards Lieut.-General Sir Thomas Baker, K.C.B.) to develop his turning movement by the Logan Valley, and across the hills by Maidan. Warnings had not been wanting. The deportation of Yakoob Khan and the various tentative means for securing tranquillity, excited nothing but enmity and distrust among the tribes.

A large contingent from Kohistan was reported to be creeping round from the north to join the gathering at Arghandi. General Macpherson by a skilful manœuvre placed his brigade in the hollow of a commanding ridge, before the Kohistanis or the Arghandi columns were aware of its presence. On the guns opening fire the hostile masses dispersed, and the infantry, Sikhs on the right, English in the centre, and Goorkhas on the left, raced down the slopes towards the enemy. The affair lasted little more than an hour. The enemy's loss was between 50 and 100.

On the 11th December, Brig.-General Massey, with four horse artillery guns and four squadrons of cavalry, rode out from the camp at Killa. This was part of General Roberts' general plan for surrounding and crushing the enemy at Arghandi. General Macpherson was to push straight along by the Pughman Hills, while General Baker was to take the enemy in rear from Maidan. The

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Killa Kasi, 2,000 yards off, made a good target for the first shells, but as villages and enclosures were rapidly left behind, the battery became hotly engaged. Round after round of shrapnel was hurled forward, but the enemy had taken the measure of the little force, and swept down with great determination.

Then it was that the want of a few hundred good rifles was severely felt. After 30 dismounted horsemen had in vain striven to make up for the deficiency, it became evident that a desperate effort must be made to save the honour of the day. Side by side the British and Indian Lancers dashed forward on their hopeless errand. The ground was unfitted for cavalry, and the enemy's loose formation offered no resistance to the shock. Of all the officers of the 9th Lancers who took part in that charge, but three escaped unscathed. Hearsey and Ricardo, of the 9th, and Forbes, of the 14th, were killed, and Lieut.-Colonel Cleland, 9th Lancers, was dangerously wounded, and he died of his wounds some months afterwards.

Retreat was still possible, but before a practicable roadway in the required direction was hit upon, the leading gun toppled over into a deep ditch, hopelessly blocking the passage for those that followed. Groups of troopers made charge after charge without checking the enemy's masses. At last, when the case was desperate, orders were given to the gunners to cut the traces and gallop off, thus avoiding the sacrifice of many valuable lives.

General Macpherson's infantry was pushing forward so rapidly, that with another hour's grace the guns would have been saved, and the brigade actually got within view of the field before the fighting was over. General Macpherson chased the enemy on the right up the hills for some miles, while his force was thus employed the guns were recovered. The carriages had been stripped and left lying by the enemy in their haste when captured; and Colonel Macgregor with a very small party of officers and men, collected as he went, was able to sally out and bring them back. At midnight the Guides' cavalry and infantry marched in from Seh Baba, having covered that day over 30 miles, the first of which over the Lataband Pass was by far the worst on the line.

None now knew better than General Roberts the arduous task that was before him, and that to re-establish our shaken prestige many valuable lives must be sacrified, and many desperate deeds attempted.

On the morning of the 12th December, the enemy's flag waved from the lofty Takht-i-Shah, and from a lower and more advanced peak, but the Sher Durwaza and the command of the city were in the hands of the 72nd. Part of Macpherson's force moving up early from Siah Sung, the attack began along the ridge. The base of the Takht-i-Shah was reached in the afternoon, but a murderous fire from the sides checked all further advance. About eight in the

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morning of the 13th, General Baker marched out past the city with a strong brigade. He sent the 92nd Highlanders straight at the heights above Bala Hissar, telling them this was the post of honour. The gallant regiment sprang forward and carried crest after crest at the point of the bayonet. A severe fight ensued. The rabble, too, from the city commenced sharpshooting from the Bala Hissar and from the walled villages on the plain. But the fire from all these quarters was steadily quelled, and finally the Guides cavalry swept across the valley, while the 9th Lancers and the Punjab Cavalry rode along the ridge itself. The enemy stood up boldly to meet them with their rifles, but the Guides charging to the cry of "Bala Hissar," had not forgotten the massacre of September, and the enemy suffered severely. On the 14th there was again heavy fighting with severe losses on both sides, and General Roberts wisely decided upon instant concentration within the Sherpur defences. The enemy failed to press his advantage, and General Macpherson's brigade reached Sherpur without serious mishap.

General Roberts now took up a defensive position, and he chose Sherpur rather than Siah Sung, or the Bala Hissar, in virtue of a decision arrived at two months before, and not under pressure of immediate necessity. The wisdom of this change of tactics after the events of the 14th was apparent to all. Reinforcements might reasonably be expected to arrive in a week. There had been no direct defeat, but five days' marching and fighting and climbing, fasting, and watching, is a severe ordeal for any troops.

From Deh Afghan right round to Bimaru, villages and walled gardens had been left standing at a convenient distance from Sherpur. These were now occupied by the enemy. The position of the little garrison that held the Latabund Pass caused great anxiety. Communication could only be held by heliograph, and at this time the sun was much obscured by clouds.

At last the tiny intermittent flash from Latabund reached Kabul and gave the welcome message that the post was safe, and the advancing brigade under General Charles Gough (afterwards General Sir Charles Gough, V.C., G.C.B.) was expected on the 22nd.

To supply the deficiency of cavalry with General Gough's Brigade, and also to secure, if possible, the bridge over the Logar, the 12th Bengal Cavalry were ordered to make their way through the enemy's position, and to join hands with that brigade. This exploit was carried out in the most gallant and spirited manner. The bridge at the Logar was found unoccupied; but at Butkhak a regiment of Afghan regulars turned out and received the brave Sowars with volleys of musketry, so they rode on 10 miles further to Lataband without drawing rein.

The hours of Mahomed Jan's greatness were now numbered. On the 23rd December, an hour before daybreak, a clear beacon fire

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shone out from the Asmai Hill. Every man in Sherpur was at once at his post, for this was the signal for the long-threatened attack. The enemy collected in thousands under Bimaru, and were rapidly increasing in numbers, running in groups of 10 and 12 from one village to another.

When the direction of the main attack became evident, General Roberts was at liberty to concentrate reserves in sufficient force to roll back the most determined assault. On the other side the attack hung fire all day, never getting past the stage of a demonstration. When the first wave of the attack on Bimaru seemed spent, and before another could gather force, General Roberts sent four guns, well escorted, through the gorge in the centre of the ridge, with orders to wheel to the right and take the enemy in flank. The moment was perfectly judged. No sooner did the Afghans perceive the cavalry and guns on their flank, than they began to retire from the nearest villages, and this retreat soon became a rout. The main body made for the Pai Manar Kotul, while on either side a multitude of stragglers dotted the snow-covered fields. The mass of the fugitives escaped unscathed, but a number of stragglers were cut up by the 5th Punjab Cavalry, and others streaming back were raked by a searching fire by the 67th from the cantonment walls.

In the afternoon the two infantry brigades moving out to the east of Sherpur, blew up the towers of some of the villages that lay in the path of General Gough's advance. In performing this service the lives of Capt. Dundas, V.C., and Lieut. Nugent, two most distinguished officers of the Royal Engineers, were sacrificed owing to a defective fuze, a mine which they had prepared exploding before they could get clear.

The enemy though they made a last demonstration on Siah Sung fell back that night upon the city, disheartened and ripe for flight. Next morning there was not an armed man to be seen, and the cavalry had a 20-mile ride, in vain pursuit, without firing a shot.

Thus ended the great Jehad of Mahomed Jan and the Moolah, Mushk-i-Alam. On the 24th General Gough with his brigade marched into Sherpur.

During the occupation of Kabul the Commanding Engineer, Colonel Æneas Perkins, had under his direction the following works to complete:—10 forts, 15 detached works, 3 large trestle bridges, numerous small ones, 4,000 yards of defence, 45 miles of road, 9 posts, also quarters for 8,000 men.

The operations carried out by the Khyber Field Force under General Bright, and by the 1st Brigade under General Charles Gough on his advance through the passes were of an extensive, varied, and arduous nature. General Gough marched from Gundamuk on the 14th December, 1879, with the following troops:—10th Bengal Lancers, 130 men; No. 5 Company, Sappers, 73 men; 2nd

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Battalion 9th Foot, 487 men; 4th Goorkhas, 375 men. The outpost at Perwan, near the Soakhal River, was held by 157 men of the 2nd Goorkhas; 6th Company, Sappers; 4 guns Hazara Mountain Battery; 50 men of the 10th Bengal Lancers. At Jugdulluk Kotul there were the 2nd and 3rd Company, Sappers, and 40 men of the 2nd Goorkhas. Jugdulluk Fort was held by 180 men of the 2nd Goorkhas, 2 guns Hazara Mountain Battery, and 90 men of the 10th Bengal Lancers.

On General Gough's arrival at Jugdulluk the whole country seemed to have risen in arms to bar his further progress, and daily skirmishes took place between the troops escorting the convoys between Pezwan and Jugdulluk. The post at Jugdulluk Kotul commanded by Major Thackeray, V.C., R.E., was attacked on three occasions, the last being on the 23rd December when he was severely wounded, and the enemy were driven off in all these attacks. On the 21st December, after seven days' severe fighting in the passes, a large convoy bringing supplies and ammunition having arrived, General Charles Gough was in a position to advance towards Kabul. The road was covered with snow, but all difficulties were overcome. The force reached Lataband without opposition, relieving the garrison at that place, and on the 24th December General Gough's force reached Kabul.

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CORPS ARCHÆOLOGIA.

THE CORPS OF ENGINEERS, IRELAND.

WE are indebted to Major J. J. Crooks for the following interesting extracts taken from the Ordnance Records in the Public Record Office, Dublin :—

LIEUTENANT-GENERAL VALLANCY.—Had been a Captain in the 10th Foot Fifty years ago, (there are no Lists of the Army extant that can give the date of his first Commission) he was an Extra Engineer in Ireland previous to the year 1759. Succeeded the late Major Corneille as Major of Engineers in the year 1761, and has since continued in the Corps.

MAJOR-GENERAL TARRANT, Came into this Kingdom as an Engineer 41 years since about the year 1760, and has continued in the Corps ever since. It is believed he came from the British Corps of Engineers to the Irish when the late Marquis of Kildare was appointed Master-General of the Ordnance.

MAJOR-GENERAL FERRIER, Came into this Country in the course of the American War sometime about the year 1778 from the Service of Portugal, was immediately appointed an Engineer with the rank of Major in the Army and has since continued in the Corps.

LIEUT.-COLONEL BROWNE, Was a Lieutenant in the 27th Foot, his first Commission in which is dated the 1st July, 1782. Was then promoted to the Captain-Lieutenancy of Engineers on the 1st October, 1789, and has since continued in the Corps.

CAPTAIN TAYLOR, Was appointed and served as Extra Engineer for some years previous to 1789, and on the formation of the Corps as it now stands was appointed First Lieutenant by Commission dated 1st April, 1796. Having succeeded to that situation from the Captain-Lieutenancy to which he had been appointed the 14th of November, 1790.

CAPTAIN-LIEUTENANT EUSTACE, Was appointed Lieutenant of Engineers 8th May, 1790, and succeeded to the Captain-Lieutenancy 1st April, 1796.

LIEUTENANT ARMIT, Was appointed the 14th November, 1783.

LIEUTENANT CORNEILLE, Was appointed an Ensign in the 39th Foot in 1791, a Lieutenant in 1793, and a Captain in the 39th in 1795. Exchanged to Half Pay and from thence was appointed to a Lieutenancy of Engineers 1st April, 1796.

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COLONEL VALLANCEY'S MEMORIAL TO THE KING.

To The King.

The Memorial of Colonel Charles Vallancey, Engineer,

Most humbly sheweth

That your Memorialist is informed through the Marquis of Buckingham of your Majesty's Pleasure to reform the Corps of Engineers in Ireland whereby your Memorialist is to become Lieutenant-Colonel, but that the Chief Engineer is to retire with his Commission and to hold the same as a sine-curâ. Your Memorialist most humbly prays leave to submit the following Circumstances to your Majesty's consideration.

That the Commission of Chief carries with it a Rank and Dignity much superior to that of Lieutenant-Colonel; it gives a Seat at the Board and in Time of War has considerable Emoluments thereto annexed.

That your Memorialist has served at Home and Abroad 45 Years, that he has done the Duty of Chief Engineer of Ireland above Twenty Years without the least Emolument whatever and has seen the Commission of Chief Engineer sold over his Head four Times to inefficient Men who held it as a sine-curâ.

That your Memorialist has had the strongest Reasons to believe that on a Reform, your Memorialist would have succeeded to the Commission of Chief Engineer of Ireland and the present chief invalided on his Rank and Pay.

Your Memorialist most humbly prays that he may succeed to the said Commission of Chief with the Pay Perquisites and Emoluments equal to the Chief of Great Britain.

Which is most humbly submitted.

CHARLES VALLANCEY,
Col. Engineer.

Dublin, 25th October, 1789.

MY LORD,

I am honored with your Lordship's private Information through Mr. Cooke, that it is His Majesty's Intention to convert the Corps of Engineers in Ireland into a Royal Company in which I am to be appointed Lieutenant-Colonel; but that Colonel Pigot is to preserve his Commission as Chief Engineer to be held sine-curâ.

Permit me to return your Lordship many Thanks for the very flattering manner in which you have conveyed this Intelligence to me by letter to General Pitt. I am to hope for your Lordship's forgiveness for here stating objections to this Mode of Promotion.

1st. It does not come up to the expectations I have had reason to entertain of this Promotion for 20 years past, of being Chief

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Engineer of Ireland, from the repeated Promises of Chief Governors, from personal conversation with the King, from Instructions several times repeated from His Majesty to the Chief Governors to place me in that Office.

2nd. The Commission of Chief conveys a Dignity to the Office, gives a Seat at the Board, and the Emoluments in Time of War are adequate to the Office.

The Salary or Income of Chiet, when I was first promised to succeed in 1766 was £1,500 a year, it was sold and reduced to £700 a year. It was afterwards reduced (because held by inefficient Men) to £365 a year, and £40 per Annum for Clerk and Draughtsman. If Colonel Pigott retires with the Commission he will take the latter Allowance from me.

When your Lordship was pleased to communicate His Majesty's Intentions of promoting me sooner after your arrival in this Country, Colonel Pigott told me, he rejoiced there was a Prospect of his retiring to his satisfaction, I had reason to believe he meant a Retirement with his Rank and Pay. If he now retires as invalided, permit me to hope your Lordship will recommend that I should fill the Office of Chief, otherways the Door is open to place another (and a Junior he must be) over my Head, or Colonel Pigott with his own Interest, that of Lord Shannon and Lord Drogheda, both of whom he serves in electioneering Matters will by some Means or other sell the Employment again over my Head.

Your Lordship will be pleased to consider that this Step of Preferment, is a very serious one to me. After 45 years spent most laboriously in the Service I am to be raised to the Pinnacle of my Preferment—to a bourn beyond which I cannot go. After so many years Service, and now in Rank superior to all the Engineers in His Majesty's Service (the Chief of Great Britain excepted), permit me my Lord to express my hopes that the lost Preferment would have brought with it, a Dignity and a decent Income, and that I might have been no longer the Slave, but the Director, and that I might have expected the Commission of Chief Engineer of Ireland, with a Salary little less than the same Rank brings in England.

Give me Leave to draw your Lordship's attention to the great Difference between the Pays of the Commanding Officer of the Irish Artillery and that of the Corps of Engineers. General Straton has 44 shillings a Day, an Ordnance House and Land—altogether worth £1,000 a Year. The Chief Engineer has 20 Shillings a Day and £24 a Year for a Lodging. The Duty of the Artillery Officer is amusement, pastime—the Duty of the Chief Engineer a perpetual attention and application in the Field or the Cabinet. I issued from Woolwich, went on Foreign Service and returned to Ireland, at the same Periods that Gentleman did, and I feel the Difference more sensibly.

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Permit me then my Lord at the Close of a long and laborious Service, and at an advanced Age in Life, to hope your Lordship's Forgiveness for the objections here made to the Mode of Preferments your Lordship has intended, and to hope that on due Consideration of the Business, your Lordship will be so indulgent to recommend the inclosed Memorial to be laid before His Majesty by your Lordship's Brother.

I have, etc.,

CHAS. VALLANCEY.

Dublin, 25th October, 1789.

MARQUIS OF BUCKINGHAM.

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REVIEW.

RIVINGTON'S NOTES ON BUILDING CONSTRUCTION.

NEW EDITION OF PARTS 1 AND 2. *Edited by* W. NOBLE TWELVETREES. (Longmans, Green & Co., 39, Paternoster Row, E.C. 1915. Price, 7s. 6d. per part).

Rivington's Notes on Building Construction are well known to many R.E. officers. The last edition of these notes was published in 1904. A new edition has now been published bringing Parts 1 and 2 up to date. There is a lot of new matter in these two volumes, notes on reinforced concrete, steel-framed buildings, etc., being added. Though there are no detailed calculations in these first two volumes there is sufficient information for the student to obtain a general idea of these comparatively new forms of construction.

Running through the two books by chapters :—

PART 1.—*Chapter* 1.—This chapter consists of building regulations, extracts from the London Building Act, together with various extracts from local bye-laws, etc.

Chapter 2. Sites and Foundations.—Clear short notes on ordinary house foundations with tables of safe loads on various earths, stones and brickwork. The loads on the latter are based on R.I.B.A. tests and give larger safe loads than most of the old military text-books. Pile driving and the bearing strength of piles is gone into at some length, useful formulæ being given. There are notes on reinforced concrete piles, extended base piles, sand piles, etc. A very useful chapter from an R.E. point of view.

Chapter 3. Timbering, Excavations, Shoring and Underpinning.—Much fuller notes than in the old edition with many new figures.

Chapter 4. Scaffolding.—This chapter is much enlarged, tall chimney scaffolding, ladder scaffolding, derrick gantries, etc., being illustrated, besides ordinary bricklayers' and masons' scaffolding.

Chapter 5. Centres and Moulds.—The new subject matter consists of various forms of moulds for concrete walls, reinforced concrete beams, columns, etc.

Chapters 6 *and* 7. Brickwork and Masonry.—The notes on the preservation of stonework are interesting.

Chapter 8. Walls, Piers and Retaining Walls.—The use of reinforced concrete in retaining walls, etc., is illustrated.

Chapter 9. Arches, Vaults and Domes.—Stone and brick arches for house construction are illustrated and explained, together with short notes on domes and vaults.

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Chapter 10. Chimneys and Setting for Stoves.—The latter part of this chapter has new notes and illustrations on the setting of domestic kitchen ranges, coppers, etc., together with the setting of different forms of heating and steam generating boilers.

Chapter 11. Damp and Sound Resisting Construction, Prevention of Dry Rot.—A useful chapter. The notes on the prevention and cure of dry rot are interesting.

Chapter 12. Iron and Steelwork.—The properties of cast-iron beams and columns with a summary of their limiting proportions is given. Standard connections for steel joists and various types of steel girders are illustrated, also steel pillars, pillar bases, and pillar foundations. There are good notes on rivets and riveting.

Chapter 13. Steel Skeleton Buildings.—This chapter is entirely new, and in view of the number of W.D. buildings that are built on this system the notes should be of use to R.E. officers.

Chapter 14. Reinforced Concrete.—The general theory of reinforced concrete is clearly expounded and particulars of various systems of reinforcement are illustrated. No calculations are given to show how the strength of reinforced structures is arrived at. Hints on the practical construction of R.C. buildings, proportions of the concrete, test loads, permissible deflection, etc., are concisely set forth and should be of use to those engaged in the supervision or design of reinforced concrete structures. The chapter ends with notes on reinforced brickwork and concrete block construction.

Chapter 15. Fire-Resisting Construction.—The chapter opens with a list of fire-resisting materials with short notes on their merits. Various forms of fire-resisting structures are then illustrated and explained.

Chapter 16. Carpentry.—The subject is well illustrated. All joints likely to be met with are explained. Tables showing sizes of floor timbers are given.

Chapter 17. Partitions.—Wooden partitions are illustrated together with drawings of concrete slab, reinforced plaster, terra cotta, and other types of modern partition.

PART 2.—*Chapter* 1. Roofs and Roofing.—Definitions of different parts of roofs are given together with a table of pitch of roofs for various materials. Permanent and dead loads on roofs are gone into with brief notes on the selection of roof forms and coverings.

Chapter 2. Timber Roofs.—Numerous illustrations of ordinary types of roof are given together with drawings of a few more complicated trusses. At the end of the chapter are tables giving sizes of roof timbers. There are illustrations of timber domes and turrets.

Chapter 3. Steel Roofs.—Various types are shown. Stress is laid on the importance of joints. Useful illustrations of these are given.

Chapter 4. Roof Coverings.—The laying of slates and tiles is gone into in detail. Notes are given on the more modern forms of roof covering, asbestos slates, reinforced asphalt, patent forms of felt roofing, corrugated steel roofing, zinc, corrugated zinc, zinc tiles, etc.

Chapter 5. Structural Plumbing.—The numerous illustrations on plumbers' work are clearly explained in the text.

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Chapter 6. Joinery.—Joiners' work is fully illustrated and explained There are good illustrations of door furniture that do not appear in the old edition.

Chapter 7. Windows and Glazing.—The majority of the illustrations are new and the execution of glaziers' work is more fully gone into than in the old edition.

Chapter 8. Stairs and Staircases.

Chapter 9. Plastering.

Chapter 10. Painting and Decorating.—Paperhanging.

Chapter 11. Drainage and Sewage Disposal.

Chapter 12. Water Supply, Plumbing and Sanitation.

Chapter 13. Sanitary Fittings.

The above six chapters have been rewritten. They are well illustrated, clearly explained and brought up to date.

Chapter 14. Heating, Ventilation and Hot-Water Supply.—The merits of hot-water radiators, hot air heating, open fires, gas fires, oil stoves, electric heaters, enclosed stoves, etc., are discussed. The different methods of heating are illustrated and explained while their comparative cost is tabulated. There are numerous clear diagrams of hot-water heating systems. There are good notes on ventilation. Domestic hot-water supply is fully explained and illustrated. Hints on sizes of hot-water pipes and boilers, etc., are also given.

Chapter 15. Gas and Electric Lighting.—There are useful tables giving the intrinsic brilliance of different lights, the amount of light required in different classes of rooms, efficiency of different kinds of burners and lights, etc. There are notes on many different kinds of gas and electric burners.

Chapter 16. Gas Fitting and Electric-Light Installation.—The chapter opens with notes on various types of illuminating gas. Pipe installation is gone into, together with gas meters, gas governors, etc. The different forms of dynamo in use are illustrated. Diagrams on wiring and cable-laying are given. House service mains and branches are illustrated and explained. A useful chapter.

Chapter 17. Electric Bells, Telephones and Lightning Conductors.—There are notes on various forms of batteries and bells. The wiring for domestic bell circuits, automatic fire alarms, burgler alarms, etc., are explained. The notes on lightning conductors are useful.

Chapter 18. Fire Equipment.—Fire-fighting equipment for private houses and for large buildings is clearly and shortly explained and illustrated.

These two volumes are a great improvement on their two predecessors. The revised versions should be useful both as standard text-books and as books of reference.

Presumably Parts 3 and 4 will be shortly republished and will contain the solution of the various stress problems met with in building construction.

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NOTICE OF MAGAZINE.

REVUE MILITAIRE SUISSE.

(*Numbers for July, August and September*, 1915).

Supplement.

THE EUROPEAN WAR.

La Manœuvre Morale des Flandres.

The critical examination of the official communiqués relating to " The European War " (*vide R.E. Journal* for June and September, 1915) was brought down in the part of the *Supplement* issued with the June number of the *Revue Militaire Suisse* to the events which had occurred in Flanders up to 15th November, 1914. In the part of the *Supplement* referred to the *manœuvre morale* in relation to the tactical aspect of the operations was fully discussed and a commencement was made with the discussion of the strategical aspect of these operations ; the examination of the latter question is continued and completed in the part of the *Supplement* issued with the July number of the *Revue*.

The Strategical Operations.

It is pointed out that an account describing tactical operations can be prepared without regard necessarily to the tenour or continuity of reports in relation to events immediately preceding such operations, but a report dealing with the strategical aspect of the same operations must be prepared with sufficient care to connect up the most recent phase of the situation described with that which immediately preceded it. It is for this reason that the German Headquarters have found themselves faced with difficulties in preparing their official communiqués ; it must be remembered that they proclaimed the complete victory of the German arms on the Aisne ; further, they subsequently confirmed the reports of their far-reaching success by calling attention to the successive checks of the enveloping movement of the Allies on the Somme. If the sole task remaining to be performed by the German Great General Staff had been to complete the victory already announced, they had somehow to explain how it was that the German forces had retired some 60 odd miles into a region in which the enemy had not, at that time, made his presence felt.

An investigation into the situation discloses clearly enough the divergence between the *manœuvre réelle* and the *manœuvre fictive ;* the fact that the German General Staff were thus driven into a corner can be traced to the fictitious accounts of the operations

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of the first two months of the War which had been given out to the public. One of two situations must have existed: either the enemy had been beaten on the Aisne and his defeat completed on the Somme; in which case, the military doctrine having vogue in Germany —a doctrine conforming to all the sound traditions of war—required, for the purposes of a successful achievement of the plan of campaign, the complete annihilation of the defeated enemy. Or the enemy was still unbroken, in which case, even more than in the first situation postulated, it was necessary not to lose sight of him. The first combinations for obtaining decisive results having failed fresh ones, possessing more certainty of success, had to be adopted. The German General Staff were, however, loathe to wipe away entirely all trace of the original plan of campaign.

The plan put into operation in Flanders to obtain the results hoped for, but not realized, first on the Marne and later on the Aisne, consisted in counter-attacks executed with the object of outflanking the enemy's strategical front; it was the third phase of the same operation, by means of which it was intended to put the Allied Armies out of action. However, this fact could not be made public without disclosing the whole truth and the want of good faith which prompted the issue of the previous communiqués. Consequently, it was necessary to create the impression that the original plan had met with complete success in its execution, and to make it appear that a new plan with a different objective had now been put into operation; the French Army having been disposed of, the campaign against Great Britain was now about to begin. The fighting before Paris, being no longer of importance since it had been virtually won, was now replaced by the "March on Calais."

The German Press recognized no other headline; henceforth all the events on the western front fell under that of the "March on Calais"; the public was led to believe that Great Britain was now the principal foe; France had been finally disposed of.

Looked at purely from the point of view of the correct principles of strategy, the march on Calais can only be considered as bluff. However, in the particular circumstances, it may be that the German General Staff misapplied these principles, thus proving themselves unequal to the task before them; or it may even be that owing to their incapacity, but in good faith, they thought it right to authorize prematurely a change in the general plan of campaign. If the latter of these two hypotheses is the true one, it would naturally detract from the capacity for leadership of the German higher command; on the other hand, it would partially clear the German Press of the reproach of bad faith, so far as its share in the *manœuvre morale* is concerned.

But from whatever point of view the German intentions are examined, the result of the operations remains the same—*a check*. The enemy had not been shaken off the line of the Aisne, Calais had not been reached. Of course the German public should have guessed the true situation, but it would appear that they did not do so. The German communiqués had made reiterated references to continued daily German successes; the inclemency of the weather had alone seemed to cause a lull. Simultaneously, references to new subsidiary activities had been

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employed to keep up the spirits of the people, namely, the Holy War in the near east, and the offensive thrust by Hindenburg in N.W. Poland, promising the capture of Warsaw at an early date.

At the beginning of November, 1914, Germany succeeded in dragging Turkey into the conflict, and whilst the incidents connected with the first battle of Ypres were in progress, the German Press announced loudly the results which were to flow from the Turkish Alliance. Islam was about to secure the victory for Austro-Germany in their struggle against the nations of the Christian faith. In his quality of Khalifa, the Sultan of Constantinople had proclaimed a Holy War throughout the Mohamedan world. On the 12th November, 1914, Berlin declared: "The Fetwa has been issued, calling on all Mohamedans to carry on the Holy War against all except the Allies (*i.e.* the Central Powers) and neutral states. Innumerable messages have been received from Persia, India, Afghanistan, Egypt, as well as declarations of solidarity from the Sunnites and Shi'ites, witnessing the complete accord of the whole Mohamedan world." In Germany, it was hoped that not only would the Faithful of the Ottoman Empire be enlisted for the prosecution of the Holy War, but practically the 300,000,000 Mussulmans of the entire world, men as well as women. Reports were published in Berlin of the friendly reception given in the Turkish capital, on the evening of the 14th November, 1914, to the German ambassador; there was much waving of the German and Turkish flags in conjunction. Nazim Bey, President of the "Young Turk" Society, made a speech in which he congratulated the followers of Islam on the fact that they were to wage war in alliance with Germany and Austria. The German ambassador returned thanks for the many manifestations of goodwill shown towards his country, and promised to make a report on the subject to his Imperial Master.

Turkey and Islam had now arrived at another milestone in their history. The hope of certain victory for the three armies, those of the Teutonic powers and that of the Golden Horn, which were now about to operate in conjunction to defend their most sacred possessions, carried conviction, it was alleged, in the east that a new era of good fortune was about to commence for Turkey and for Islam; the Musulmans with the aid of their new allies would now be able to shake off the yoke of France, of Great Britain, and of Russia. The columns of the German Press were filled with matter containing information of the above nature emanating from Turkey, and such matter was placed in juxtaposition with the bulletins of the German General Staff, which persistently continued to announce that favourable progress was being made by German troops at Dixmude and at Ypres.

Again, Hindenburg once more loomed large in the columns of the Press. At the time the Austro-Hungarian forces were yielding all along the line before the Russian advance in Western Galicia, he launched his great counter-offensive against the Russians from Kalisch and from Thorn. The Russians now in their turn began to fall back along their whole front. The future was full of promise; new plans were in execution, it was necessary to forget the "March on Calais" for the "March on Warsaw" had now begun.

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The Commencement of the 1915 *Campaign.*

An examination of the Press service in connection with some of the winter battles of 1914 and those of the following spring sheds fresh light on the *rôle* played by the official publicity agents, and on the methods adopted by the information services in France and in Germany.

The rigours of the winter necessarily involved a slackening off in the operations; the relative inactivity at the Front caused an increase in the risk that demoralization might set in. This was the case not only as regards the combatants, but to a still greater extent, it applied to the civil population which, being less active, unaccustomed to military discipline, withdrawn from the beneficial reaction which arises from contact with danger, was thus necessarily more apprehensive as to what might be in store by reason of the suddenness of the lull. Since the transformation taking place in the character of the operations was coincident with the change in the season it was thought that the risks introduced into the situation by this apparent calm were increased. The broad outlines of the minor tactics to be adopted in the attack and defence of entrenched positions had now been gradually evolved and standardized. At the end of the autumn of 1914, the transformation above referred to was completed. The battles in Flanders were the last act in the War of field operations of the old style. The fronts were now firmly held fast from Switzerland to the North Sea. The stirring movements of the old style battle tactics gave place to the dilatory procedure of siege operations and, in consequence, winter seemed to have acquired in duration a life of double the normal period. Looking back on the events of this period it may be said: the affair of Soissons was a German success, the engagements in the Champagne a partial French success, the capture of the Crête des Éparges a local French success; later, the second battle of Ypres, in the springtime, a German defeat.

The Affair of Soissons.

At the beginning of January, 1914, the Germans faced the French about 3 miles north of Soissons, astride the Soissons-Laon railway. To the east of the railway, the German trenches had been established on the plateau to the north of Crouy from Perrière to Vregny; the plateau has a command of 395 to 425 ft. above the River Aisne; on the west these trenches extended to a round hill about 1,400 yards N.W. of Crouy. The French attacked the advanced positions and carried them. They made good their hold on the position in the days following, repelling the enemy's counter-attacks, and on the 10th January last made a further advance, wresting from the Germans their trenches N.W. of Crouy, and also a part of their line on the Perrière plateau. The day following, the French dug some new trenches in order to strengthen the position captured by them, but on the 12th January, the Germans made a vigorous counter-attack which caused the French to retire from the positions recently won by them. On the 13th January, the French in their turn made a counter-attack on the line Cuffies-Crouy, which proved abortive, whilst to the east of the line last mentioned the

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French troops fell back to the line Le Moncel-Sainte Marguerite-Missy. A little later, the French troops retreated to the south of the Aisne. The communiqués published by the two sides between the 9th and 15th January inclusive are reproduced in full in the *Supplement*. These communiqués give very divergent accounts of what took place. The French version follows, day by day, the progress of the French attack between the 8th and 11th January inclusive; the German version denies the French claims categorically. At one point the German reports are self-contradictory, for after having claimed that for two whole days the German troops had repulsed, with great loss to the enemy, all attacks, it is admitted that on the 11th January the French had established themselves in a part of the German fire trenches. From the 13th January, the French communiqués announce successive retirements from positions recently held by their troops, and the Germans at once sound notes of triumph. The course followed in the German communiqués is exactly similar to that adopted at the beginning of the War; reverses are ignored, successes are magnified up to the extreme limits.

Although the affair of Soissons resulted in a French failure, the engagements cannot be considered to have been more than a local tactical success for the Germans. In their communiqués the Germans compared the fighting with that of St. Privat; this was manifestly an exaggeration.

Since the end of the offensive operations of August, 1914, the German arms had met with no success. The German plan of campaign had not been carried through and the war of attrition, which followed the failures in Flanders, had not, for the space of two months, provided any occasion for announcements which would cause elation in the German mind. Encouraging assurances are, from time to time, a necessity and may, perhaps, have been more so in Germany than in the countries of the Allies by reason of the expectation of rapid victories which was so persistently preached by the military and governmental authorities during the mobilization period. Hence the references to the 1870 War, which acted as a reminder of the successes of a brilliant period in the history of the German Army.

On the French side an effort was naturally made to produce a contrary impression; it must not be understood by this that any effort was made to deny the real results of the engagement. The French retreat was admitted, but explained away as being in the nature of a simple accident due to climatic conditions.

Comparing the series of communiqués issued by the two General Staffs, it can be at once seen that the pompous reports of the German General Staff were framed with the distinct object of stimulating both the army and the civil population; on the other hand, the references to the fight issued by the French General Staff would appear to have been drafted with a view to allaying anxieties which might be caused by a reverse just when recent victories might have led the public to expect rapid decisive results.

The final paragraphs of a German report on the affair of Soissons are reproduced *in extenso* in the *Supplement;* in it " the energy, science and

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boldness of the higher command, and the magnificent exploits" of the army are extolled in superlative terms.

The French report deals with the causes which prevented the success of the operations; the Aisne was in spate, the bridges over it were broken down, and in consequence the movements of the French troops between the two banks of the river were hindered. The enemy took advantage of this situation and counter-attacked vigorously. After dealing with the incidents of the fight, the report reverts once again to the influence exercised on the French operations by the flood waters of the Aisne. The explanation given may be accepted as the genuine cause of the failure of the French attack; many examples are to be found in the history of wars in which similar untoward circumstances have been responsible for the miscarriage of well-laid plans. It may well be conceived that causes independent of the conduct of the men and the dispositions of their leaders did exercise some influence on the situation. However, whatever may be the true explanation as to the causes which led to the withdrawal of the French troops, it is clearly manifest that after two months of operations in the neighbourhood of Soissons without any apparent result, the General Staffs on the two sides found it necessary on the first opportunity which offered to adopt measures for raising the spirits of their own side, and on the other side, to prevent a drooping in that of theirs.

The two accounts disagree as regards certain details; for example, the German version claims that the success of the German troops occurred in an area having a depth of from 2 to 4 kilometres and a front of from 12 to 15 kilometres. The French version states that the French troops retired for a distance of less than 1,800 metres on a front of less than 5 kilometres. It is not possible to measure off on a map, very exactly, the actual area affected; approximately, however, its depth was 2½ kilometres and its front extended along a line which measures 5 kilometres.

The part played by the German Press in relation to this affair is next examined under the title "La Manœuvre de Presse Allemande." It is necessary to realize that the German success at Soissons was a well-conducted feat of arms of purely local value, but of no strategical consequence. As soon as the victorious troops reached the line of the Aisne, they had to suspend their operations and made no effort to continue and complete them on the days following. No serious attempt was made to cross the river; the German attack appears to have been made on a shallow front. It is these circumstances which endow the literature which was poured out after this episode with its characteristic qualities. The Press was brought into requisition towards the end of the Battle of Ypres. To it was assigned the task of converting a fleeting action into a strategic operation of far-reaching consequences and of representing it as the introduction to a decisive event.

The element of romance in the statements published was even more pronounced than that present in the accounts relating to the important fights in Flanders. These latter engagements had daily offered materials for the Press service; when these fights ceased the references to them also ceased. After the affair of Soissons comments thereon continued

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to be published in order to hold the public attention. The fight at Soissons ended on the 14th January, 1915, the Press campaign in relation thereto continued till the 20th and 21st *idem*.

It was *viâ* Copenhagen that the Berlin Press Bureau introduced the subject; in order to make known, according to custom, the German version of the affair to neutrals, a despatch dated 15th January, 1915, announced that since the beginning of that month a strenuous fight had developed on the heights north of Soissons. At first the French, it said, had succeeded in driving back the Germans; but in their turn the latter had taken the offensive, and by a vigorous attack had forced the French to retire, who in doing so had surrendered the possession of heights of strategic importance into German hands. The Germans, it was claimed, had thus acquired command of the Josienne Valley and also of the important main railway line and the two main roads between Chauvy and Laon, lying in this valley. At the same time, a despatch from Geneva called attention to an announcement alleged to have been made in the issue of the Parisian *Guerre Mondiale* of the 14th January, 1915, in relation to the "serious defeat of the French" in connection with an attack on the heights north of Soissons by General Maunoury with two brigades sent against Crouy, which were repulsed, thus bringing the fight to a close; the defeat of the French was said not only to be *complete* but they were alleged *to be retreating in great disorder*.

The *Berliner Lokalanzeiger* announced that the fighting on the plateau of Vregny had taken place under the eyes of the Kaiser, and called attention to the importance of the French attack. Finally, a dispatch from Berlin stated:—"In its report the French General Staff has been obliged to admit a German success at Soissons. The position of General Maunoury has been jeopardized by this check."

The military critic of the *Stockholmer Dagblad* commenting on the military situation in France and in Belgium now took note of the definite check which the French generalissimo's offensive had sustained; considerable attention was paid to this check after the unauthorized publication of the order of the 17th December, 1914. Certain information, reaching the military critic referred to above, had indicated that a great move had been determined upon in order to deliver France from the German invader; the check in consequence acquired very great significance, as indicating that the Allies did not at that time possess sufficient resources to justify them in counting with certainty on victory. The German success at Soissons appeared, according to the Stockholm account, to have more than local value. The apparent failure of the French offensive along a tolerably extensive front also seemed to have strengthened the German position, and to have reduced the chances of the Allies bringing off a decision favourable to themselves.

The news alleged to have been received from France was still more suggestive than that coming from neutral countries. The *Berliner Lokalanzeiger* announced that a private message received by this paper disclosed that: "The great progress of the Germans on the banks of the Aisne is upsetting the French Military Press." The general nervousness on the part of the French was, it was alleged, also on the increase, and many families residing on the two banks of the Aisne had fled from their

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homes and had taken refuge in Paris. *Le Petit Parisien* endeavoured to calm the Parisian public, but without success. During this time, Berlin caused it to be made known that the German Press was celebrating the success of the German Army at Soissons; it was claimed that this was the most notable success obtained on the western front in four months of war. In spite of the statements to the contrary the affair of Soissons was but of local value, and, as had been done before by the German Press, a red herring was again trailed across the path in the shape of the Zeppelin raids on Yarmouth, Sheringham, Cromer, King's Lynn, and Sandringham. Here was something to excite the interests of the German nation; these air raids were held to be worthy of the superiority in the science of war possessed by Germany. Moreover, England at last was thereby made to feel the weight of her misdeeds in attempting to starve the German people; she had received the just reward of her sins against humanity. The raid was a magnificent advertisement. This new theme, fertile in developments, marked the end of the *manœuvre morale* in relation to the affair of Soissons.

The Engagements in the Champagne.

The engagements in the Champagne seem to mark a new development in the official press service of the Imperial Great General Staff. At no period of the War on the western front has the disagreement in the communiqués published by the belligerents been more absolute and more persistent than in connection with the events in the Champagne. This period extends from the 16th February to 11th March, 1915; it was, however, preceded by many phases of purely local operations. The first of these phases is that of December, 1914, during which the French took the offensive and made some progress on the line Perthes-Le Mesnil-Massiges. The second phase lasted from the 25th January to the 4th February, 1914; this was a period of German counter-attacks followed by renewed activity on the part of the French, which carried the latter's line still further to the north. The third period extended from the 17th February to the middle of March, 1914; the communiqués issued by the two sides during this period are reproduced, side by side, in the *Supplement*. The two versions absolutely contradict one another. In Germany, the Press Bureau published a commentary on the strategic aspect of the operations, which was in the nature of a scalp dance and was manifestly intended to influence public opinion. Considerable difficulty would, however, have been experienced in finding clear evidence of a victory gained during the three weeks' battle, in which the positions of the opposing forces were scarcely altered. In France, the necessity had to be explained for such long-continued fighting which created the impression that a decisive offensive movement had been attempted, leading certainly to heavy losses, but which resulted only in a French advance of from 1¼ to 2 miles.

This part of the *Supplement* concludes with a German commentary on the operations dated 10th March, 1915; attention being drawn therein to the fact that the operations reported during the past few days were the termination of the "Winter battle in the Champagne" and that, as already announced on the 17th February last, this battle

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was born of the intention of the French Commander-in-Chief to ease the pressure on the Russians, then engaged in a desperate struggle with Hindenburg's commandoes, in the region of the Masurian Lakes, by a stroke which would pierce the German lines—Vouziers being for this purpose the first objective of the Allies. The commentary continues:—"The issue known as the Battle of the Masurian Lakes shows that this result has in no way been obtained. And as to the attempt to break the German lines, it can to-day be affirmed that the attempt has completely and lamentably failed. In spite of all the allegations contained in the French official communiqués the enemy has not succeeded in obtaining the smallest advantage."

The credit for this result is given to "the heroic conduct of our troops, and to the prudence and perseverance of their chiefs," pre-eminent among the latter, it is stated, being Colonel-General von Einem. It is claimed that two weak Rhenish divisions had since the 16th February held, by day and by night without respite, a front of 5 miles against more than six army corps, at full strength, which were hurled against the German front in succession; these army corps being supported by heavy artillery which, being provided with ammunition of French and *American* manufacture, it is said, often fired more than 100,000 rounds in the 24 hours. It is stated that the Rhenish Battalions and the battalions of the Guard which had maintained themselves with unshakable resolution against enemy forces possessing a sixfold superiority in numbers took 2,450 unwounded prisoners, including 35 officers. An admission is made that the German losses were heavy "owing to the bravery of the enemy's troops"; it is claimed, however, that these losses were not made in vain, since the enemy's casualties have been estimated to have been threefold as great, namely more than 45,000 men. Finally it is stated: "Our front in the Champagne is more solid than ever. The French efforts have had no influence on the course of events in the eastern theatre. German bravery and tenacity have acquired a new title to glory, equal in value to that won almost at the same time in the region of the Masurian Lakes."

The part of the *Supplement* issued with the August number of the *Revue* contains a French reply to the foregoing German commentary; it is dated 12th March, 1915. In the first paragraph of this reply it is stated: "The operations which have been in progress in the Champagne for some weeks past have completely attained the object with which they were undertaken. This object had a two-fold character, local and general." The local results are next set out. Continuous progress, it is claimed, has been made; the Germans in spite of innumerable and violent attacks have never been able to retake from the French troops the positions captured from them. The French gain is stated to have represented an advance, in relation to the positions occupied at the end of December, 1914, of from $1\frac{1}{4}$ to 2 miles on a front of about $4\frac{1}{2}$ miles; and to have made the French masters of a line of heights which afforded a favourable base as a starting point for new attacks. The German losses are said to have been heavy, *inter alia*, two regiments of the Guard having been entirely wiped out. The reply continues: "Now,

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the numbers of the enemy engaged have varied between 4 to 5½ army corps, and we have found on the battlefield nearly 10,000 German corpses. We have made nearly 2,000 prisoners, belonging to five different army corps, and taken automatic guns and many machine guns." The general result obtained is next dealt with; it is referred to in the following terms:—"The essential object of the operations begun by us on the 16th February in the Champagne was to hold at this part of our front as large a number as possible of German troops, to cause them to expend large quantities of ammunition, and to prevent completely the transfer of additional German troops to Russia. This result has been completely attained."

These operations caused the Germans to reinforce this portion of the front, between the 16th February and 10th March, with 20 battalions (including 6 battalions of the Guard), 1 regiment field artillery and 2 heavy batteries (of the Guard); a total equivalent to about 1 army corps. Even with these reinforcements the Germans gained no advantage; on the contrary, they found it impossible to send any additional troops to Russia, and thus was given to the Russians the opportunity to achieve their brilliant success between the 25th February and 3rd March, when they captured 10,000 prisoners and many guns from the retreating Germans. A great part of the German reinforcements sent to the Champagne front was withdrawn from the northern portion of the lines opposite the British front in Belgium; this was taken advantage of by the British Army, and it scored a success in this region on the 10th March. The reference to the general result attained concludes as follows:—"Thus once more there was in evidence, to the great benefit of the Allied Armies, the close combination of the operations, not only along the western front itself but also between this and the eastern front." Attention is next turned to the German admission made in the commentary of the 10th March, already referred to. It is pointed out firstly that the Germans admit that the French operations in the Champagne began at the period of the German success in the region of the Masurian Lakes; but they omit to state that from and after the 25th February the German success was transformed into a decided check. Secondly, that although the Germans claim that only "two weak divisions" were employed in the Champagne by them yet they mention by name two army commanders, belonging to von Einem's army, who were engaged in this region, and also refer to battalions of the Guard (brought from the north) and "other units called to their support." Thirdly, that in the commentary the German Army is stated to have lost more men in the Champagne than in the battles of the Masurian Lakes; it is known that 14 German army corps and 3 cavalry divisions were engaged in the latter battles. Stress is laid on the point that however substantial the French success in the Champagne may have been, it would still have been exceedingly difficult to cause casualties in "two weak divisions" approaching in numbers anywhere near the heavy losses suffered in Russia by the 14 German army corps. The foregoing statements would lead to the conclusion that 10 divisions are more likely to have been engaged on this front rather than the two divisions referred to in the

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German accounts. Finally, it is stated: "Our operations in the Champagne:—

"(*a*) Have been an uninterrupted series of local successes and have only caused us relatively small loss and very few prisoners;

"(*b*) Have inflicted enormous losses on the enemy, superior even to those suffered by him in Russia at the same time;

"(*c*) Have obliged him to concentrate on this part of the front 5 army corps and to expend large quantities of ammunition.

"(*d*) Have contributed towards the brilliant successes won by the Russian and by the British troops;

"(*e*) Have drawn from the German General Staff explanations which amount to an admission."

The two versions of these operations are next examined and compared. The first point noted is that if the French General Staff had formed the intention to pierce the German front, it is evident that their plan did not meet with success. French troops gained ground, it is true, and wrested some trenches from the enemy, but behind these new lines were constructed by the Germans, and finally, in spite of the success obtained by the French, all operations were suspended. The fact is, it was realized by the French General Staff that too heavy a price was being paid and the object to be gained did not justify the further expenditure involved; in commercial language, the French General Staff decided, under the circumstances stated, to cut their losses. On the other hand, if the French General Staff planned the operations in the Champagne with the object of retaining German troops in the west so as indirectly to assist the Russians, a recourse to the *manœuvre morale* for the purpose of removing any ill-effects which might be produced on the public mind by the cessation of these operations can clearly be understood. Having in view the persistence with which attacks had been made in the region of Perthes, close to the bluffs of the Argonne, and assuming that a success there would free the Argonne of the invader, the public, it would appear, had set their hopes on a more patent success than the indirect one connected with the relieving of German pressure on the Russians; the public dreamt rather of an actual victory in the West. There was victory in the making, but it did not materialize. Attention ought to have been drawn to the strength of the enemy's defence works, and the difficulty experienced by the French leaders and their men in carrying them. This probably explains the subsidiary efforts of the French Official Press Service to throw light on the events and to soften the shadows; hence the importance attached to the German commentary, as shown by the length of the reply made thereto, with all the attendant risks of a newspaper warfare.

As regards the strategic result which the French claim to have obtained, which claim the Germans on their part strenuously deny, the former produce in evidence the victory gained by the Russians at the very time that the operations in the Champagne began to support their case, whilst the latter point to the reversal in the relative *rôles* of the Russian and German Armies on the Niemen from and after the 25th

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February, when the pursuing Russians were converted into the pursued army.

But what the Germans put forward as evidence in support of their claim is not conclusive; it may perhaps only prove to be evidence of a defeat if examined closely in connection with the statement that two weak German divisions alone were engaged. The French evidence is also not conclusive; it is more in the nature of an assumption. It cannot be definitely stated, without further information, that the German General Staff had the intention of removing troops from the Champagne front in order to utilize them as reinforcements in East Prussia, unless it can also be shown that other troops were not available for the purpose. Only when the orders issued to the troops on the two sides and the detailed accounts in relation to the operations on the different fronts are made public will it be possible to decide in favour of one or other of the contradictory claims.

It is easier to come to a conclusion in relation to the value of the information contained in the official telegrams published daily. It is patent that there was an absolute lack of sincerity in the German version; it is only necessary to study, on a map, the movements reported to realize this, but there are also many other presumptions which afford weighty corroborative evidence. First of all, there was the general plan of the battle; it consisted of a scheme which was repeated almost exactly practically every day. The French attacked vigorously; a desperate hand-to-hand struggle took place; they were thrown back on to their original positions. Very often the German counterstroke was delivered instantly after the attack. Sometimes the French succeeded in getting a footing along small sections of the trenches, but if they were not expelled the same day, they were certainly driven out on the day following, that is of course according to the German accounts. Very frequently the failure of the French attacks were announced in very categorical terms: "All the French attacks were crumpled up by our fire," and so on. Instinctively, one asks the question why, in the presence of results so disastrous to the aggressor, did not the defender counter-attack, not only in view of his traditions, but above all in the light of the experience gained in the present trench warfare which has established the value of counter-attacks? Can it be that the defender wore down his opponent, but did not take advantage of the latter's exhaustion to seize his trenches! According to his own version, the defender was content to assume the passive defensive condemned in his own *Training Manual;* a method of warfare never practised by him in peace time, because held to be faulty. Consider next the German statement that only two German divisions were engaged and the French retort that the prisoners taken belonged to five different army corps. In order to make the French evidence conclusive the number of regiments to which the prisoners belonged should also have been given. It is quite conceivable not only that the two divisions referred to belonged to different army corps but the reinforcements pushed to the front may also have been drawn from three other army corps. More reliable evidence on this point is to be obtained by examining the incidents of the struggle, and by comparing, in the light of this examination, the French

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version of the battle with the German version. The battle front extended from a point, on the borders of a wood, situated about 500 yards N.W. of Perthes to the farm Beauséjour about 1,600 yards N.E. of Mesnil-Les-Hurlus—a front of about 4¾ miles. The battle began on the 16th February, by the French wresting about 2 miles (in length) of the trenches from the Germans; the latter counter-attacked ten times, but without meeting with success. The French, on the other hand, continued to be successful and won about another 850 yards of trench, on the 17th February, to the N.W. of Perthes. The French strengthened their position along their new line; in the meantime they had to meet two violent counter-attacks, one on the night of February 17th—18th and the other on the morning of 18th February; in the succeeding night the Germans delivered five more counter-attacks. The fighting continued in this fashion for a fortnight or so, and on the 3rd March the positions held by the French represented an advance, from their original line, of about 1,100 yards, on a front of nearly 4 miles. Up to this date, the French had become aware that they had before them in this region German troops belonging to the VI. and VIII. Active Army Corps and the X. and XII. Reserve Army Corps. The Prussian Guard now appeared on the scene on this part of the French front, and took part in a number of counter-attacks made to the north of Mesnil. During a counter-attack which was made on the 4th March it was definitely proved that at least two regiments of the Guard Corps were on this part of the front. The German counter-attacks, however, continued ineffectual. Between the date last mentioned and the 11th March, the French continued to make progress and the Germans retaliated with counter-attacks, occasionally winning back small sections of the trenches lost by them, only to be later expelled therefrom. When the French broke off the engagement on the 11th March, their front had been carried on their left to the northern edge of the wood, about 2 miles N.W. of Perthes, and ran thence along the Souain-Tahure Road; and on their right, to a point about 2½ miles eastward of Tahure. The line of trenches captured from the Germans extended to a depth of about 1¼ miles along a front of about 4½ miles. Having regard to the number of the German counter-attacks and to the extent of their trenches captured, it must be admitted that in connection with these operations, which covered a period of three weeks during which counter-attacks were delivered sometimes at one point of the French front, sometimes at another, and occasionally along the whole length of the 4½-mile front on which the French were operating, the Germans have shown extreme modesty in representing that only "two weak Rhenish divisions" took part therein; the silence observed in relation to the part played by the regiments of the Guard and to the efforts of the German troops generally to annihilate the French troops, alleged to have been beaten, may, it is suggested, also be attributed to the natural modesty of the German character.

The German telegrams relating to the Battle of the Aisne are recalled, and the similarity of the treatment by the German Official Press Service of the fighting on the extensive front between the Oise and Verdun, and of the operations on the narrow front of 4¾ miles at Perthes is put on

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record. There was no change in the methods previously adopted by the German Press Bureau, nor in the liveliness of their imagination.

A systematic and absolute denial of German reverses was the guiding principle on which the Official Press Service continued to be based, and it is in this respect that the French and German methods still differed. Whenever the German arms suffered a reverse the occasion seems to have been seized upon for denying that such was the case; evidence of this is to be found in connection with the accounts of the engagements in the Argonne, which preceded those in the Champagne.

The Engagements in the Argonne.

The operations in this region afford an example of the means employed by the German publicity service, in a situation where successes and reverses constantly alternated, to suppress references to the latter of the alternating aspects of an engagement, in order to create the impression of a series of uninterrupted German successes.

It is probable no one can be found who is prepared to state definitely that the fighting in the wooded country of the Argonne has not been without appreciable influence on the general trend of the operations in the western theatre. During the long period that the German Army sought to resume the offensive on the Aisne and later on the Oise, the Argonne region was believed to be the scene of what are termed *attaques principales*. Day after day, the Germans denied that they had gained ground in this region; but they appear at no time to have carried their advance to the south of the Bois de la Grurie. From and after November, 1914, it was the French who in their turn announced various successes; however, the general situation showed scarcely any change. The incident of the 11th and 12th February (occurring before the big engagements in the Champagne) was referred to in communiqués of both belligerents; it really produced no essential modification in the state of affairs then existing.

The relative situation of the localities affected affords an explanation on this matter. The contours of the Argonne bluffs are, in a way, similar to those of the back of a donkey; these bluffs lie from north to south between the Aisne and the Aire. Two main roads, namely that connecting Clermont and Ste. Menehould and that between Varennes and Vienne-Le-Château connect the two valleys mentioned. About 2½ miles north of the latter main road a forest track, passing through the Bois de la Grurie, more or less parallel to it, connects Montblainville and Vienne. Still further to the north, another forest track connects Apremont and Binarville. Between the two tracks the forest is thick, with much undergrowth, and the ground is much cut up with more or less deep ravines.

After their retreat from the Marne the German columns marched along the borders of the wooded heights of the Argonne, without entering this region; the German retirement stopped short at the Varennes-Vienne-Le-Château main road, and the two exits thereto from the Argonne forest were occupied by them. The tactical principles inculcated in every country agree in directing pursuing troops to get on to the flanks, if possible, of the retreating foe; the double advantage being

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gained thereby that the pursuing troops do not run the risk of being held up by the enemy's rear-guards and further the retirement of the detachments on the flanks of the retreating troops is accelerated, thus reducing the risk of menace to the flanks and rear of the pursuers. The French troops followed the injunction referred to; they entered the forest, between the Aisne and the Aire, at Clermont and Ste. Menehould, and advanced along the central road from Les Islettes on Four de Paris. They pushed on to the first of the forest tracks mentioned earlier, prepared to form front either towards the east or the west. The Germans, desiring to cover their *points d'appui* at Varennes and Vienne, also entered the wooded heights, but were not able to move far on the western border of the forest, as the French troops had made good their hold on this edge from Binarville to Vienne-Le-Château. By degrees the French were able to push their right and centre as far as the banks of the Aisne; the Germans, however, maintained their position on the line Vienne-Le-Château-Melzicourt. On the east, the French were unable to push their way to the edge of the forest; here they came into collision with a strong force of the XIV. German Army Corps, between Varenne and Montblainville. It was in the region last mentioned that the autumn, winter, and spring campaign of 1914–15 took place. The French established themselves on a north to south line, north of the Varennes-Vienne main road; during the period of the German success in October, 1914, they wrested some trenches on this line from the French and penetrated some distance into the forest south of the Varennes-Vienne main road, but a French counter-attack made during the last days of October expelled the Germans from many of the trenches captured by them.

From this time to the date of the commencement of the operations in the Champagne no change took place in the situation. The two French lines remained back to back; the western line being partly in rear of the German front at Vienne, whilst the Germans held trenches on the right flank of the French eastern line.

The German General Staff have published a pamphlet entitled, *Die Kämpfe im Argonnerwald*, dealing with the operations in the Argonne; it was reviewed in the number of the *Journal des Débats* for the 10th February, 1915, extracts being published to show the character of the wood fighting in fortified positions. The Germans, it is stated, drove three mine galleries from their fire trench, on the 7th December, towards the French position; the right and centre galleries were carried to within 18 to 20 yards and the left gallery within 8 yards of the French trenches. The French were however prepared and exploded a countermine under the German left gallery and blew in 10 yards of it. By the 19th December, the Germans had repaired the damage done and also pushed forward their right and centre galleries to within 6 to 8 yards of the French trenches; from the heads of these galleries they drove branch galleries, about 3 yards long, and established a line of mines which were exploded at 8 a.m. on the 20th December. The assaulting columns which were held in readiness bounded forward and carried the French trenches. The *Débats* draws attention to the fact that the German account omits to make mention of the recapture, by the French,

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of two-thirds of the trenches lost by them. This account gives some idea of the manner the German public was kept informed of the progress of events in the Argonne, on the eve of the engagements in the Champagne. Attention was drawn, in connection with the Battle of the Marne, to the official communiqués published in Germany for propaganda purposes. An extract is given from the *Kriegschronik*, a monthly production in German and French, published at Berlin, in which the operations taking place in the Argonne during January, 1915, are summarized; German successes and French checks are alone referred to. During January, according to the *Kriegschronik*, 81 victories were gained in the land war by German troops, excluding the Turkish successes, and not the smallest reverse was suffered. The only reservation there is concerns the Austrians; it is related, under the date 8th January, 1915: "Owing to the appearance of superior Russian forces, the Austrian troops which had advanced beyond the Carpathians, in Bukovina, had withdrawn to the principal passes." The defeat of the Ottoman Army by the Russians on the 26th January is referred to in the following terms:—"Owing to bad weather, the operations in the different parts of the Caucasus have been suspended." During this same period at least a dozen failures and definite reverses were admitted in the French communiqués, exclusive of the Soissons affair, and a number of fleeting reverses, in which the French finally rectified their failures.

Various Episodes occurring between 10th February and 9th March, 1915.

Attention is next devoted to certain episodes which occurred during the period 10th February—9th March, 1915, whilst the operations in the Champagne were in progress.

The first of these episodes is that connected with the French defence of the work Marie-Thérèse, in the Argonne region: this work, which constitutes a particularly pronounced salient in the Bois de la Grurie, was the scene of a strenuously contested fight which took place on the 10th and 11th February. The German communiqués in relation thereto create the impression that a German offensive had resulted in a success, local it is true, but concerning which there could not be a shadow of a doubt; the exact locality of the success did not appear to be considered of much importance. It was stated that the enemy had suffered serious loss, but no mention was made of their own casualties.

The French telegraphic accounts of this same episode give a picture of a defensive stand which was crowned with success, but at a considerable sacrifice in lives. The amplified French account, covering the operations 7th—17th February, admits that, although the French troops gained a success, it was not absolute; further, it is admitted the Germans had also gained ground, their advance being estimated at 20 yards. The essential details of the episode are reproduced from the amplified French account in the *Supplement*.

It is not necessary to consider how far the details made public in the two versions correspond with the actual facts, but to consider alone the publicity methods adopted on the two sides. Both in the telegraphic and the amplified French accounts no hesitation is shown in admitting

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a reverse; in the later account, the reverse is referred to quite openly, because the episode being at an end, there was now nothing in it to alarm the public. The German account, as usual, claims a success without any qualification and disparages the enemy, who is alleged to have been defeated owing to his definite inferiority.

The episodes of Saint Eloi and of Roclincourt are next dealt with. An official telegram, emanating from Berlin on the 15th February, announced that the German troops had taken possession of a part of the enemy's position for a length of about 990 yards, and that counter-attacks had been delivered by the enemy without achieving any success. On the two following days German telegrams announced that the attempts made by the British and French troops to recapture the trenches, which the German troops had wrested from the British, had proved fruitless. The French Press Service made no reference to the incident in its communiqués of the 15th February, but on the day following it announced that the British troops had on the previous day retaken the two sections of trench, between Saint Eloi and the Ypres Canal, lost on the 14th February. This information was confirmed, a statement being published that after two days' hard fighting the British had regained the lost trenches. The British Press Service followed the example of the French Service. The termination of the episode was awaited before mention was made of it; on the 17th February, the announcement was made that the enemy had attacked the British front in the Ypres region and had succeeded in capturing many sections of the trenches, but that these had been won back by counter-attacks during the succeeding days. The whole truth regarding this episode will not be known until the full details regarding it are published by the two sides; the situation is similar to that in relation to the engagements in the Champagne mentioned earlier in this Review. On to the episode of Saint Eloi there was grafted another, analogous thereto, which occurred on the 17th February to the N.W. of Roclincourt. The German and French accounts relating to this episode flatly contradict one another; in the former, it is stated that the French had been expelled from the German trenches on the Arras-Lille road, captured by them, whilst in the latter account it is claimed that the German attempts to regain these trenches were repulsed with heavy loss to them. The French version of the episode bears the impress of truth, whilst the German version is a shuffling statement which contains its own condemnation.

Another of the incidents briefly dealt with is that known as the Episode of Norroy and of the Xon Peak. The Xon Peak, a sugar-loaf shaped mountain the summit of which is about 1,200 ft. above sea level, is situated to the north of Pont-à-Mousson on the right bank of the Moselle; its western slope descends in a sharp gradient towards the Moselle, whilst its eastern slope dies away gradually towards the Seille. About 1,100 yards from the summit of this peak, and N.E. of it, lies the hamlet of Norroy. On the 14th February, a Berlin communiqué announced that German troops had wrested the hamlet and peak from the enemy, taking 2 officers and 11 men prisoners. No mention was made of the incident for three days, but on the 18th February the German Press published a statement to the effect that after the complete

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destruction of the trenches, the peak and the hamlet had been evacuated by German troops; further it continues: "The enemy have made no attempt to retake the position by force of arms."

In the German account of this affair the public is asked to believe that although the lives of German soldiers were risked in the operations to capture the Xon Peak, the only object in view was to destroy the entrenchments and then after a three days' German occupation of the position quietly to surrender the latter to the enemy again. Further, it is extraordinary to think any public could be made to believe that the value of this position, from which the approaches to Pont-à-Mousson and the bridge over the Moselle (only 2 miles distant) could be directly commanded, was in reality so little esteemed by the German Commander; and that the French, having been driven out of works forming a bridge-head, would make no effort to regain the same. However, the French have placed on record their version of this little affair. On the 14th February, the public first became aware that the French troops had met with a mishap in this locality, and on the 19th *idem* learnt from a communiqué issued that morning of the termination of the episode, communicated to them in the following terms:—"In Lorraine, in the Xon region, we have delivered an attack which has enabled us to regain the village of Norroy and to reoccupy the whole position. The announcement made by the Germans in their communiqué to the effect that they *evacuated* Norroy is untrue; they were *chased out* of the place."

Next there follows a reference to the Episode of Vauquois; the struggle which developed round Vauquois was something more than an episode, it was really a battle. It is the German account of this affair which creates the impression that it was merely a very minor incident. Both the German and French versions agree in stating that there were two distinct phases in the action. The first phase commenced on the 18th February and was referred to in communications from Berlin, bearing this date and of the day following, which stated that the French attacks directed against the German position Boureuilles-Vauquois had ended in the enemy being completely checked, with the loss of 5 officers 479 unwounded men taken prisoners. The French telegrams of the 18th February allude to this action in the following terms:—"We have made some progress in the Boureuilles region."

The second phase commenced on the 28th February; the communiqués, issued between the 1st and 6th March, in relation thereto are published in parallel columns. The German version of the episode conforms strictly to the traditions of its Press Service; it represents a defensive battle, passive but victorious; the enemy, it is alleged, made many useless attacks each of which was crumpled up. The French version also conforms to the traditions of its Press Service; a picture of the fight is given of this incident which has a truer ring about it than that issued from Berlin.

The part of the *Supplement* issued with the August number of the *Revue* concludes with an introduction to the Episode of Notre-Dame-de Lorrette, the account of this affair being continued and terminated in the part of the *Supplement* belonging to the September number of the *Revue.*

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The Episode of Notre-Dame-de-Lorette was only an incident in the long-drawn fight, which ended in May, 1915, resulting in the capture by the French of the heights of Notre-Dame-de-Lorrette, N.W. of Arras. This incident occurred just at the time that the Episode of Vauquois was terminating. The French and German communiqués in relation to this affair, issued from the 4th to 8th March last inclusive, are reproduced in parallel columns in the *Supplement*, information concerning the subsequent operations being given in a summarized form in the text. This is another of the cases in which it is at present impossible to say exactly what did happen. In the French communiqué of the 4th March it was announced that the Germans had seized the French trenches near Notre-Dame-de-Lorette. The German communiqué of the same date contained the additional information that the extent of the position gained was 1,750 yards and that 8 French officers and 558 men together with some guns had been captured. On the 5th March, the French communiqué stated, "We have retaken the greater part of the trenches lost the day before yesterday and have made 150 prisoners"; and the subsequent telegrams show that the French continued to make progress in this region. The German telegrams, however, persisted in announcing the failure of the French efforts; and indeed on the 9th March a Berlin telegram stated, "Our troops have wrested from the French two new trenches." Even in the month of May, after the French had captured the works which made them masters of the Lorette Heights, the German communiqués continued to announce the repulse of the enemy's attacks with heavy loss to them. The German version creates the impression of a German attack which was successful from the outset and produced definite results; the French version admits a German success, but also tells of a French counter-attack which ended in the positions lost being regained. From the tactical point of view both accounts are correct. However, one thing raises a suspicion against the German version; the sudden cessation of information on this situation on the very day that the French claim a victory in categorical terms. Since the French version in the beginning admitted a check, there are no grounds for questioning its veracity. The fact stands out that the French did not obstinately continue to deny a German success, whereas according to custom the Berlin accounts did deny the French success.

The Episode of Badonvillers, which took place on the 27th February last and the succeeding days, is the last of these incidents; this particular episode has, up to the present time, remained an enigma. On the 28th February last, a German official telegram announced that on the preceding day the French had been driven from their positions on the line Blamont-Bionville, after violent fighting on the eastern borders of the Vosges. The German offensive had carried their front to the line Verdenal-Bremenil-Badonvillers-Celles; this offensive, said the telegram, has thrown the enemy back $3\frac{3}{4}$ miles on a front of $12\frac{1}{2}$ miles. All the attempts of the enemy to reoccupy the area lost have failed with heavy loss to him. The manner of presentation of this information was such that it might well attract attention; nothing like this measure of success had been heard of since the victories of the previous August. Even

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the Battle of Soissons had not obtained a success on the same scale. The French telegrams did not furnish any explanation on the subject. On the following day, the Berlin communiqué had no additional information to give on the subject, but appeared rather to reduce the importance of the engagement to that of a local incident. A French communiqué now made the announcement that there had been stiff fighting in the Vosges at La Chapelotte, north of Celles, and that the Germans had been completely repulsed. There was probably some advanced work connected with frontier defence at Chapelotte, and it is possible a purely local scrap at this point had been magnified by the Germans into an engagement on a 12½-mile front. For some days no other places were spoken of. The two sides continued to publish reports contradicting one another, the only point on which they were in accord was the locality of the collision.

Conclusions on the Engagements in the Champagne.

The engagements in the Champagne are important from the point of view that they mark a change in the western theatre from a German offensive to that of an Allied offensive; and coincidently with this transfer of the initiative from the one side to the other, there also took place a very important transformation in the tactics hitherto employed, namely a change from the ordinary methods of field warfare to those of siege operations.

Up to the period of the Battle of the Marne, the German offensive had proved very violent and ceaseless; the formidable and surging German torrent had upset all obstacles in its path. The Marne position was in the nature of a breakwater against which the advancing German wave broke and was thrown back, but although the waters receded the intention to cause an inundation was not abandoned. The broken waters were turned into other channels, with the object of avoiding the first obstacle to their progress, but at the Somme, the Lys, and the Yser, their flow was again interrupted. The battles in Flanders were the last assault; here the torrent was finally dispersed.

The Allies now took steps to recover the ground lost and attempted to do so by undertaking a large number of local operations. This procedure was ineffectual. The loss of cohesion and the demoralization of the German Army was not such as to cause them to give ground on a large scale.

The engagements in the Champagne led to a more pronounced form of offensive battle in a predetermined sector, the attack in depth, but accompanied by the obligations imposed by the new tactical methods—these obligations being imposed by the strength and solidity of the trenches as well as the power of the weapons in use. The strength and solidity of the trenches in the present campaign have made an intense artillery bombardment a necessity, the bombardment being succeeded by an immediate and brusque infantry assault with hand grenades and the bayonet. In consequence the process of winning victory has slowed down in order to correspond to the new pace set by field manœuvres. Victory too now consists in gains of apparently doubtful value obtained by the sustained efforts of considerable forces operating on a narrow

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front. In the Champagne, victory has been on the side of the Allies; since it is their enemy who has retired; further, all the latter's efforts to regain the region evacuated have failed along the front won back by the Allies and consolidated by them.

The combatants in contact with one another alone realize the truth in relation to the actual situation at the front. A few hundred yards to the right or to the left of the fire trenches or a few hundred yards in rear of them, all the information available is hearsay, and the official publicity service possesses the advantage of being able to represent even the loss of trenches as a theoretical victory; this service it is which supplies news to journalists and the public, who, both far removed from the scene of operations, desire to learn of victories alone and are impatient in regard to checks and failures.

The engagements in the Champagne have been the first in which previously unheard-of conditions have prevailed; it therefore becomes necessary to study with special care the official telegrams relating to these operations. The motives which have been actuating the Official Press Services in France and in Germany, since the Battle of the Marne, have been widely different. In France, an improving situation has had to be dealt with; the accounts published have announced the successes won with due moderation. In Germany, having in view the fact that the spirits of the populace have had to be maintained in consequence of the Allies having assumed the offensive, the Press Service has judged it expedient not only to deny, in the most absolute terms, all German reverses, but has even gone the length of claiming the victory of last winter in the Champagne.

The evidence in favour of the French version is as follows:—

1. The general description of the fighting corresponds with the sort of thing past experience has led one to expect, and agrees with the military doctrines preached in Germany, and is not, like the fighting described in the German version, a mere paper scheme.
2. The movements, if followed on a map, indicate a natural progress and seem to pursue so normal a course in relation to the places mentioned as to appeal to one's sense of logic.
3. The German accounts have consistently denied the successes of the Allies in every part of the field of operations from Switzerland to the North Sea, both before and after the periods of the struggles in the Champagne. The situation created has been altogether unreal, in no war has one combatant been able to have it all his own way for so long a time when all the advantages, small as well as big, have been always and constantly on the side of his victorious adversary.

Judged by all the precedents of the period August, 1914, to January, 1915, it is on the French version that the history of the War, when it comes to be written, will be founded.

During the months of August and September the German General Staff were carried away by their pride; they had wished for war without any misgivings, having persuaded themselves that the superiority of the

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German Army over that of the French Army was such as to make success for their side certain. In the early reverses they only saw fleeting accidents, consequently it was permissible to dissimulate in relation to them; moreover, it was probable that successes would follow almost immediately to wipe away all trace of the reverses, and all would then be well. In the contrary case, if successes did not follow, it would be necessary to prevaricate; the Press Service would put forth all its resources to assist in this game.

During the engagements in the Champagne pride was probably no longer the motive for the *manœuvres de presse*, but rather was it mother necessity. The situation had changed much since the victories of the early days of the War. An early peace on German terms was no longer the immediate prospect; it was now a question of a deferred peace on honourable terms. The necessities of the situation made it incumbent on the German Government to dissimulate once again both in relation to the War by land as in relation to that on the sea.

The Capture of les Eparges.

Three considerable tactical crises are associated with the names of Combres and les Eparges; the first occurred on the 17th February, 1915, and following days; the second lasted from the 18th to 21st March; the third from the 5th to the 12th April.

The ridge of les Eparges, situated on the confines of the Woëvre region, forms the forward crest of the Meuse Heights. The Germans occupied this ridge on the 21st September, 1914, at the time that they succeeded in driving in their wedge towards St. Mihiel. The village of les Eparges, however, remained in French hands, as well as the valleys and slopes further to the north, including the Côte des Hures; on the 9th February last, the French also took St. Remy by a *coup de main*. The Germans had firmly established themselves on the ridge of les Eparges, their trenches and works being arranged so as to give several tiers of fire; this position gave them command over a great extent of country and over the important roads between les Eparges and St. Remy and between Combres and St. Remy. The first of the tactical crises in this region had its origin in the destruction of the German defences, effected by the explosion of French mines on the 17th February last, which was followed by a prolonged struggle, of a fluctuating character, between the contending parties. At first, the Germans were taken by surprise, but later they recovered their senses, and delivered a successful counter-attack on the 18th February, robbing the French completely of the fruits of their first success. Still later on the same day, victory once more smiled on the French troops and, by the morning of the 19th *idem*, the German works were once again in French hands; as on the previous day the Germans counter-attacked and recovered their works, but only for a short while. The French were, however, not left in peaceful possession of the captured works; the Bavarians made four attempts to retake these trenches and only ceased their efforts at midnight of the 19th—20th February. The situation of the French troops nevertheless remained precarious and in order to make their position more secure an attack was ordered on the morning of the 20th

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February against the German defences on the eastern spur of the heights of les Eparges. Another fluctuating struggle ensued which ended in the French finally gaining the upper hand, with the gain of some yards of German trenches; thus ended the first crisis. Let us now consider for a moment the *manœuvre morale* in relation to this affair.

At first, there was no mention of the struggle either in France or in Germany. Silence was first broken on the subject on the 19th February; on this date it was announced that the German Headquarters had published a statement to the effect that French troops, after gaining a success near Combres (east of Verdun), had been repulsed with heavy loss. The French telegram, in relation to this affair, sent out at 7 a.m. on the date last mentioned, stated: "We gained ground at les Eparges, on the Heights of the Meuse, on the 17th, and have retained our hold on the position won in spite of the enemy's counter-attacks." This account gives the final result of the fighting, without entering into the kaleidoscopic changes of the struggle, and conforms to precedent. The German telegram also conforms to the traditions observed in Berlin; its date is prior to the final German reverse of the evening of the 18th February and may have been issued before the news of the reverse reached German Headquarters. If this was the case, it would have been honest to announce the fact on the following day. Unfortunately, not only was this not done, but information actually published later, states the very contrary. On the 20th February, the German Headquarters announced that the French were repulsed at Combres, to the north of Verdun, and that fighting was still in progress in this region. At this time the German Headquarters must have been in full possession of the true situation. Twenty-four hours later, a German telegram of the 21st February announced that, near Combres, "three French attacks, delivered by a considerable force and with great persistence, had been repulsed with great loss to the enemy." On this occasion, as in connection with the Liège situation in the first days of war, the German Headquarters resorted to barefaced equivocation. All that can be said is that the principles on which they acted were identical to those guiding them in the past. The German public remained in ignorance of the small change which had taken place in the situation at les Eparges between the 17th—21st February, 1915, to the prejudice of their troops, as they had remained ignorant of the larger change of a similar nature which took place on the Marne, between the 6th—11th September, 1914.

French telegrams, dated 20th to 22nd February, dealing with this situation, are reproduced in the *Supplement*: they refer to the German counter-attacks against the trenches captured from them; and the last of them shows that the seventh German counter-attack had failed to carry the position which the French had captured ten days earlier.

The *Journal Officiel* of the 16th April, 1915, contains a recapitulation of the operations in the region of les Eparges; in this account it is stated that three French battalions took part in the second tactical crisis at les Eparges. These battalions made attacks on the German position from the 18th—21st March, but made little progress; an attack delivered on the 27th March by a French battalion of chasseurs

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was more successful. The French and German communiqués, issued from the 19th to the 22nd March, in relation to this crisis are reproduced in the *Supplement*. Those issued on the succeeding dates were framed on similar lines to the communiqués reproduced. The German accounts make no mention of the success gained by the French battalion of chasseurs on the 27th March; the French communiqué of the 28th *idem*, however, announces that this battalion captured 150 yards of German trench. Put shortly, a claim is put forward in the French version that the operations during the second crisis had resulted in a further improvement in the position gained by the French troops, since the first crisis ended; the German version, on the other hand, maintains that the relative positions of the two sides showed no change in relation even to the situation prior to the first crisis.

The third crisis had its origin in the operations undertaken by two French regiments for the purpose of capturing the western and eastern extremities of the crest along the summit of les Eparges; the operations began at 4 p.m. on the 5th April, 1915, there being two phases in the first stage thereof. As was the case at the beginning of the first crisis in the previous February, the French early in the day seized a portion of the German trenches and established themselves therein; on the east the French attack was held up by aerial torpedoes fired by the Germans on the French troops. At 4.30 a.m. next morning the Germans brought up fresh troops, which fought most gallantly, and the French had to give way before them. The same evening the French troops returned to the attack, and again captured some of the enemy's trenches on both wings of the German position at this point. The Germans made constant counter-attacks, but they were unable to gain a footing in the works they had recently lost. Fresh German troops were now brought up and made a lodgement in the trenches held by the French troops, who thereupon retired. It was the turn of the French now to await reinforcements; the Germans, however, were too exhausted to push their counter-attack further. The French and German telegrams, of the 6th—8th April, containing an account of the operations are reproduced in parallel columns in the *Supplement*. The Berlin telegram of 6th April agrees with the French account of what was taking place. The telegrams of the two sides, dated 8th April, in no way agree; these two accounts can only be reconciled on the assumption that Berlin deliberately wished to create a confusion in the public mind in relation to the ridge of les Eparges and the plateau of Combres. A mixture of truth and untruth was incorporated in the German telegram in such a way as to create the impression that the German troops had been victorious, yet this was contrary to the actual facts of the situation.

On the morning of the 8th April, the struggle entered on its second phase. Reinforcements having reached the French, an attack was undertaken to capture the summit of les Eparges; it was reached by French troops at 10 a.m. The fight, however, continued for the whole day, and it was only at midnight of the 8th—9th April that the French could really say, with correctness, that they were in possession of the whole

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of the German works on the summit. The Germans, however, continued to hold a small triangular patch on the eastern extremity of the crest. The French made themselves possessors of this triangular patch during the third and last phase of this crisis; to do this an additional regiment had, on the 9th April, to be brought up as reinforcements. It was not till the evening of the date last mentioned that the French felt themselves to be really masters of these heights; they had to meet a final counter-attack during the night of the 11th—12th April, and repelled it. The French and German communiqués issued during the 9th to 10th April are reproduced in the *Supplement*; they recall those relating to the engagements in the Champagne. These messages absolutely contradict one another as well in regard to details as to the results obtained. The French version mentions the two last attacks as taking place on the night of 9th—10th April; whereas the German version gives the date as the morning of 11th April, and even emphasizes this point. If it could be assumed that the Berlin report of the 11th April referred to the date on which information was sent by the German General Headquarters, the discrepancies could be explained; however, it is known that this is not the case since, in a general account of the engagements between the Meuse and the Moselle published, on the 16th April, by the German General Headquarters, it is again stated that the French attack was made on the 11th April. After the final capture of the Summit of les Eparges on the 9th April, the French attempted to make themselves masters of the Combres Heights but were repulsed. It is therefore quite possible that the Germans, in accordance with a habitual practice, may have hoped to mask the defeat at les Eparges by the success at Combres. But this hypothesis has to be considered by the light of the French communiqué of the 12th April, relating to the events of the preceding day; it states: "No infantry action has been reported in the region of les Eparges and *Combres* (not underlined in the original French telegram) since our success of 9th April." If this information is correct, one is driven to the conclusion that it is a lie and not an equivocation which has to be dealt with. The French documents have all along spoken only of their *success at les Eparges*, and as a matter of fact the dominating ridge is situated at les Eparges and not on the small plateau of Combres; this tangled explanation throws a strong suspicion on the *bona fides* of the German General Headquarters and creates an unfavourable impression.

The author of the *Supplement* article finally records his conclusions on this situation. He states that, leaving aside the contradictions in dates and other details referred to above and limiting attention merely to an appreciation of the results, the operations around les Eparges must be judged by the same standards as those employed in the case of the engagements in the Champagne. It is patent that there had been a local victory for the French; they had captured a work commanding the enemy's position, after driving the latter therefrom. But the French success had not been carried far enough to include the lower ridge of the plateau of Combres; consequently the French did not reach a point immediately in rear of the German lines at Saint-Mihiel. According to the German accounts, had the French attempted, on the 11th April,

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to get in rear of the Germans at the place last named, they would not have succeeded in doing so. But to deny the capture of the upper ridge by the French as the German Headquarters did, is equivalent to saying that the French did not succeed in carrying the works on the summit of les Eparges, that on the 12th April, when the struggle ceased, the two sides were exactly in the same positions as they occupied on the 16th February last; in a word, the German version amounts to a suggestion that the story of the varying incidents of this prolonged attack was born of the fertile imagination of their adversary. This really is the limit and even the most complaisant may well refuse to have their credulity imposed upon to the extent of accepting such a suggestion as being within the possible bounds of truth. The German version would have one believe that in this case, they were fighting a passive defensive battle, and that the French repeatedly advanced to the attack, being repulsed on each occasion. The only difference between the German version of the fighting in the Champagne and that in relation to the affair at les Eparges lies in the admission that in the former case the French attack followed the line of advance indicated in the French communiqués, whilst in the latter case an equivocation is resorted to as regards the line of the French attack, further there was at the outset a suppression of all reference to the repulse of the German troops although this was admitted later. The latter account was certainly more ingeniously framed than the former, but this did not make it any the more true.

As has already been stated, the French efforts between the Meuse and the Moselle to straighten out the German wedge towards Saint-Mihiel failed; this wedge therefore remained directed towards the Meuse, but it had been slightly squeezed in. Even if the original intentions and hopes of the French had not been able to produce results beyond this, it was nevertheless justifiable to apply the term "*offensive reconnaissances*," actually employed in the French communiqués, to describe the incidents in the Woëvre. On the other hand, if the situation was really otherwise the use of this term was but the employment of the *manœuvre morale* for the purpose of minimizing the failure, just as the furious denials of the slightest repulse were so in the case of the German accounts.

The Battle of Neuve Chapelle.

In order to support the conclusions arrived at in relation to the engagements in the Champagne and the fighting in the region between the Meuse and the Moselle, it is interesting to compare the British and German telegrams. The former have, generally speaking, inspired a measure of confidence, whilst experience has made it necessary to put limits on the veracity attributable to the latter. Sir John French's retreat during 23rd—26th August, 1914, was represented by Berlin telegrams as a disorderly flight which must end in the definite dispersal of the British forces. However, a little later, these same British troops were found in line with the French Army, pushing the Germans back at the point of the bayonet. To-day, it can be said, in relation to the German accounts on the one hand and the report sent by Sir Edward

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Grey on the 20th August, 1914, to the British Ambassador at Berne on the other, that it is the latter which is the more worthy of credence.

The British, moreover, have standing to the credit of their account the precedent created in the Boer War; it is remembered that their defeats, during the first months of that campaign, were immediately chronicled. It is a matter of national character. The British are sportsmen; they make it a practice to play the game; sports develop loyalty. The task of reporting is easier to the British reporter than to any other, not only because the possession of sangfroid is inherent in the British people, but also because danger, being more distant, their sangfroid is put to a smaller strain. In their island home, the British are protected from violent blows; they know or believe that they are little exposed to danger; and they who have no reason to fear are able to bear without any great effort the influences which affect others. Such is human nature. A serious accident next door to a man's home moves him more than one of a hundredfold greater magnitude at the Antipodes. It is not a question of *learning* whether it goes well or ill, but rather whether *it is* well or ill. The *manœuvre morale* only preoccupies itself *with that which is.*

The British Navy looms large in the eyes of the British public; it has secured supremacy on the wide seas. The British Army is less in evidence; it has not been considered an essential element in providing for the safety and greatness of the British Empire; it has been destined to take part in distant expeditions, the conquest and retention of colonies. On the Continent, it is otherwise; it is the French Army which defends the sacred soil of France. Loyalty to the *entente cordiale* it is that caused Great Britain to contribute a few divisions for the land campaign in addition to her major contribution of a powerful Navy to preserve the free use of the seas to the Triple Entente. Public opinion in Great Britain has, from the commencement, demanded that whether the news from the Front be good or bad it shall be made known immediately and with candour; it is the whole truth and nothing but the truth that is asked for; this attitude of the public has rendered the task of the reporters an easy one.

Attention is called to Sir John French's dispatch of 5th April last containing an account of the Battle of Neuve Chapelle. At the time that this battle took place the Russian Army was making headway with marked success against the violent and repeated attacks of Hindenburg's army; in the general interest of the Entente Powers it was necessary to ease the pressure on the Russians by holding as large a number as possible of German troops in the western theatre; the French co-operated with the British, with the object of attaining this end, by their operations in the Champagne and in the region of Arras. The Battle of Neuve Chapelle commenced at 7.30 a.m. on the 10th March last by a formidable artillery bombardment of the German positions. Half an hour later, two brigades of the 8th British Division and an Indian Brigade delivered an attack against the German trenches, along the front of which the wire entanglements had been demolished by artillery fire. Well-sustained rifle and artillery fire was directed against the German defences, and the whole village of Neuve Chapelle and the roads

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leading from its eastern extremity towards the north and south-west fell into the hands of the British troops. During this time, the British artillery kept up a heavy shrapnel fire on the ground near the village so as to prevent the Germans pushing forward reinforcements. It now became necessary for the British to make good their hold on the position gained, and to reorganize the units which had taken part in the attack and had in consequence become mixed; a task made particularly difficult, as the enemy was still able to bring machine-gun fire to bear on all the approaches of the village and it was already nightfall. The attack was renewed on the following day, but it soon became evident that progress was impossible, since there were still many buildings and other points occupied by the enemy which had not yet been bombarded. Sir John French draws attention, in his report, to the unfavourable atmospheric conditions which prevailed on the 11th March, and to the fact that the telephone lines between the gun positions and the observation stations had been all cut. Reference is also made in the report to the counter-attacks made by the Germans on the date last named, it being further stated in the dispatch that the main object in view having been attained, and for other good and sufficient reasons, the G.O.C. 1st British Army was directed to discontinue the offensive movements and to maintain and consolidate the ground gained. The general impression created by the British official account is the same as that produced by the French accounts of the fighting in the Champagne; a victory won, but at great cost, and of which the victor was unable to take advantage. The heavy losses are admitted, but the results obtained, although partial, are held to have been sufficient to justify the expenditure in men. The British and German telegrams of the 11th—14th March are reproduced in the *Supplement;* on the 15th *idem* the discontinuance of these operations was announced by the British Field Marshal, but the Germans made no further reference thereto; to make up for it, however, the latter announced, on the date last mentioned, that German troops had made good progress at St. Eloi, south of Ypres—this position being occupied by the British. The progress was later converted into a definite German success. On the 16th March, the German Headquarters announced: "The British position on the heights near St. Eloi, south of Ypres, a struggle for the possession of which was in progress last evening, has fallen into our hands." This information was correct; on the 16th March the British Commander-in-Chief reported the loss of the position as having taken place on the 14th *idem,* adding that the greater part of the lost trenches had been regained on the succeeding morning. The German telegrams make no mention of the latter detail. Nevertheless the German procedure differs in this case from their past practice; the public are let in a little behind the scenes in a way they had not been earlier. The Berlin telegrams of the 11th—13th March tell of the *penetration, at certain points, of the British troops into Neuve Chapelle;* the *manœuvre morale* consists no longer of mere negation but rather of a simple manœuvre directed towards minimizing the results obtained by the enemy. Without doubt the check to the Germans had been too prompt and too marked to make it possible for them to contest the point. Wholesale denials had already raised too great an outcry of

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indignation to be again resorted to, and had caused some surprise even in the ranks of the German Army. The German Press Service, therefore, fell back on the *manœuvre* of minimizing results, and, on this occasion, with some artistic success. First the tone of the three German telegrams was such as to give the impression that the affair was a very trifling incident; it was a skirmish rather than a battle. So true was this, that no announcement was made of any efforts to retake the village. The German commander had suddenly hit on an idea; an attack was prepared; but later realizing that the enemy was in far too superior strength, he had as suddenly decided not to put his plan into operation. Even from the German point of view the British telegram of the 13th March is more true and gave a more accurate picture of the situation. The German accounts are even silent on the subject of the counter-attacks made against the British position on the night 11th—12th March. This silence gains in importance by reason of the official measures taken, during the following days, to hide these German activities with a view no doubt to reducing still further the importance of the reverse which was admitted. As usual, the German Press Service dragged in the neutral Press to its aid. Quotations are made from a report emanating from Amsterdam on the 20th March, in which reference is made to a letter stated to have been contributed to the *Times* by an Army medical officer. It is alleged that, in the letter in question, the writer announces that wounded are coming back, day and night, from the Front, and that the hospitals are all full. This Amsterdam report was accompanied by another from Stockholm containing the information that the military correspondent of the *Gœteborger Handelstidning* had made it known that the British losses at Neuve Chapelle were *exceptionally heavy;* that the British casualties were estimated at 12,000 men, the battle having been *the bloodiest local combat* of the War. Two days later the subject was enlarged upon. It is now the turn of London directly to contribute its quota to the literature prepared for keeping up the spirit of the Teuton; in a report alleged to have been received from the British capital the statement is made to occur: "The list of the losses in officers at Neuve Chapelle increases with each fresh issue. The consternation, throughout the country, is profound, as may be judged by the brief observations which, in some cases, appear in the Press with the endless casualty lists now being published."

An extract from a report dated Rotterdam 23rd March last is reproduced in the *Supplement;* therein it is stated that the *Nieuwe Rotterdamsche Courant* publishes a statement on the strength of a London report to the effect that great preparations were in hand in London and all the large provincial centres for the reception of the wounded from Neuve Chapelle.

These reports of the 20th—23rd March were only a preliminary to the crowning effort of the German Press launched on the 24th *idem;* on this occasion the German Press published a statement to the effect that the British public were clamouring for the truth, which was being hidden from them, to be disclosed to them. References were also made to a public meeting held in Kensington Hall to protest against the

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action of the Government in hiding unfavourable news from the Front. In the *Supplement* to the *Revue* the order which Prince Rupprecht of Bavaria issued to his Army after Neuve Chapelle is next reproduced *in extenso;* in this order the Royal Commander alleges that 43 British battalions were employed to oust 3 German battalions from their positions.

To summarize the situation :—Whilst the British claimed, in their version of the fighting, that they had captured German trenches on a front of about 4,000 yards, estimating the German casualties at 16,000 to 17,000 men, and considered the affair from its magnitude as being a battle ; on the other hand, in the German *campagne morale* it is admitted that a battle did take place, but only on the British side ; the British Commander-in-Chief is stated to have brought into action some 43 battalions —2 army corps—and to have lost 20,000 men at least on a conservative estimate. On the other hand, on the German side, properly speaking, there was no battle ; yet, mark you, three German battalions proved sufficient to inflict casualties on the British troops amounting to 20,000 men ; after this measure of success the commander of these three battalions generously renounced the idea of retaking Neuve Chapelle, the village being a position of no importance. The documentary evidence yet to be produced can alone make the real situation known. At present all that can be said is that, on this occasion also, the German Headquarters took exceeding good care to prevent any appearance of a success, be it ever so fleeting, on the part of their enemy, being admitted in their accounts of the Battle of Neuve Chapelle.

This part of the *Supplement* also contains a part of the account relating to the fighting round Hill 60.

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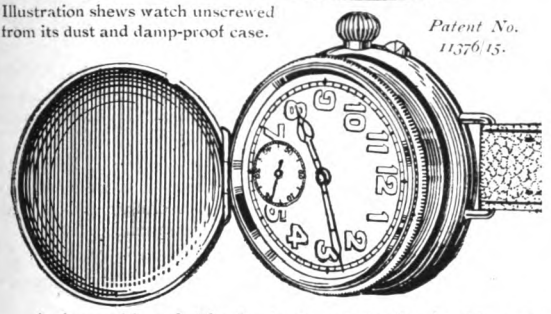

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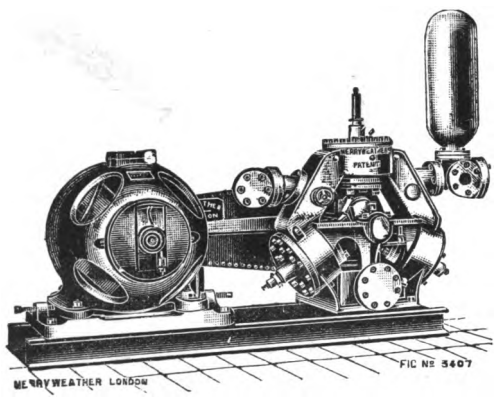

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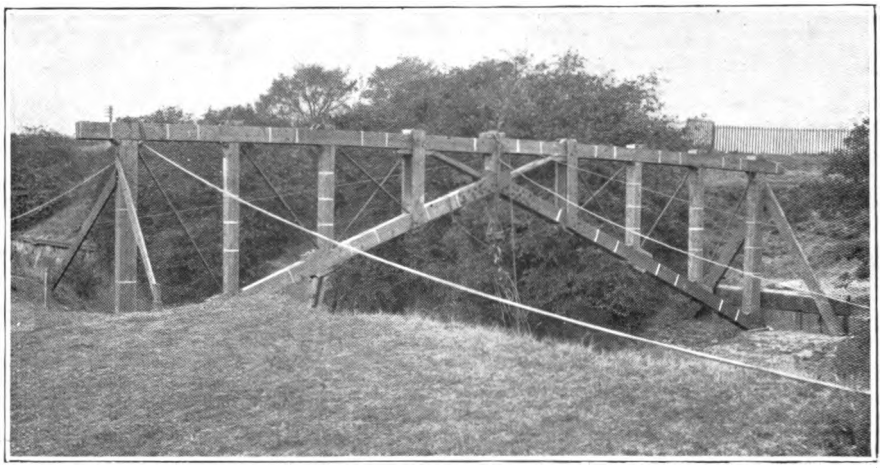

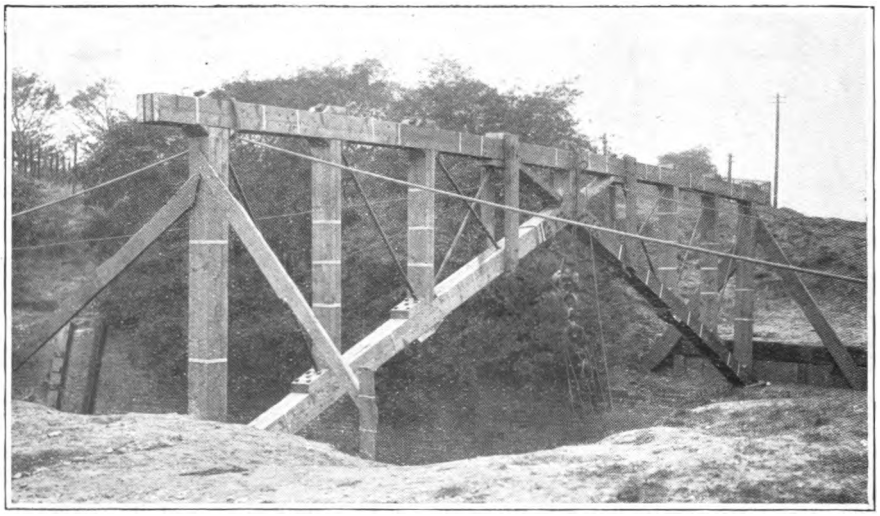

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REPLACEMENT OF DESTROYED MASONRY ARCH WITH THREE-HINGED TIMBER-BRACED ARCH.

By CAPT. G. C. GOWLLAND, R.E.

PRIOR to the advent of heavy motor transport, heavier mobile guns, etc., it was as a rule unnecessary, when making a road report, to go into much detail as to the actual strength of the road bridges. It was generally assumed that all existing bridges, including bridges on 2nd and 3rd class roads, would safely bear any train of military vehicles. Bridges on 1st class roads may usually be assumed to be strong enough to carry all modern military transport, but this is not always the case with bridges on 2nd and 3rd class roads. In England nearly all the bridges on by-roads have notices fixed to them stating what are the greatest axle loads they are capable of carrying. These permissible weights often fall short of the requirements of the heavy train of a modern army. In reporting on roads, it may therefore often be necessary for R.E. officers to quickly decide what weights can be safely carried by existing road bridges. Steel girder bridges are of modern design and will usually be safe, but if their carrying capacity is doubtful they can be quickly measured up and their strength calculated. Reinforced concrete bridges being still more modern than the steel are still more likely to be safe. The difficulty arises when old masonry bridges are under consideration. Many of these bridges have been in existence for a long time and were designed at a period when a farm waggon or a stage coach was the heaviest vehicle on the road. An officer of the Corps may be called upon to decide what load any one of these old bridges can carry with safety. The quickest guide in making a decision of this kind is to use some empirical formula, such as is found in Trautwine's or other engineering pocket books.

If a masonry arch and its abutments are safe according to the formula the bridge can be passed as safe for all military traffic. These formulæ are of course only a guide for use in the field. To get more accurate information the line of resistance in the arch ring under consideration must be found and must of course fall within certain limits. This sort of work however cannot be done by the roadside and hence the value of some formula which can quickly be applied to any segmental or elliptical arch.

Besides deciding whether existing masonry bridges are safe for military traffic it may be necessary for the R.E. to quickly replace

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masonry arches that have been destroyed by the enemy. In cases of this sort empirical rules are not much use as it is necessary to find out what is going on in abutments, etc., when an arch ring has been demolished. Take as an example an ordinary brick arch road bridge.

Consider the abutment G A F E (*Fig.* 1) with the arch intact and no

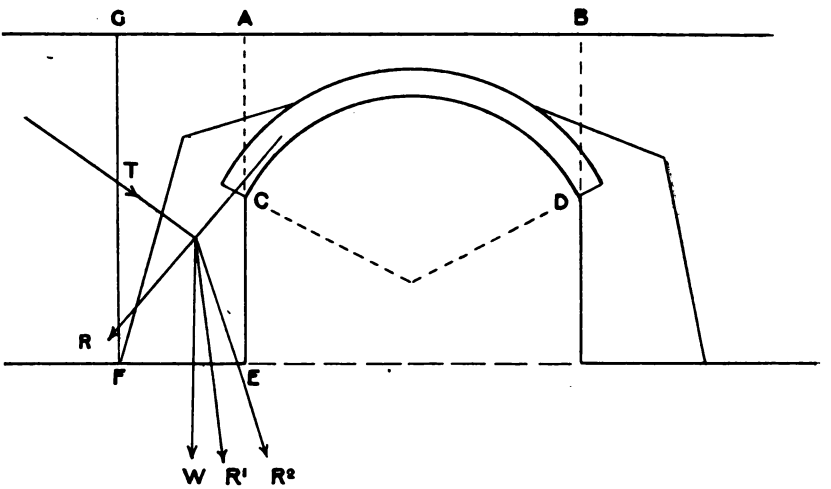

FIG. 1.

rolling load on the bridge. The abutment is acted on by :—R the minimum arch thrust, *i.e.*, the arch thrust due to the dead load, T the earth thrust, and W the weight of the abutment itself. These three forces have a reaction R_1 which should pass inside the centre third of the bed joist F E if the bridge is properly designed.

Suppose that the arch A B C D is blown down. This means that R the minimum arch thrust is removed and that R_2 the resultant of all the forces acting on the abutment will act nearer to E as indicated in *Fig.* 2, R_2 being quite near to E and passing outside the centre third of the bed joint F E. This means there is tension in the mortar in the left face of the abutment. The abutment will be shaken by the explosion and probably the mortar will not be very reliable when under tension. The result will be that the abutment will be on the point of collapse under the earth thrust only. Suppose that a girder bridge is erected in place of the demolished arch as indicated in *Fig.* 2. The abutment G A E F is still on the point of collapse, though it will be slightly assisted in holding up by the weight of the girder bridge, but it is quite possible that any rolling load advancing to cross the girder bridge may cause the abutment to collapse before the load reaches the bridge itself. With the rolling load in the position shown in *Fig.* 2 T the earth thrust is maximum while W the weight of the

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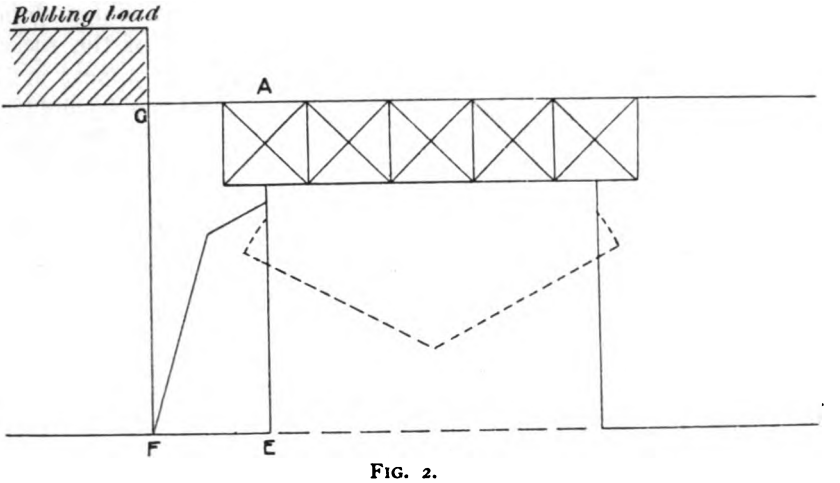

FIG. 2.

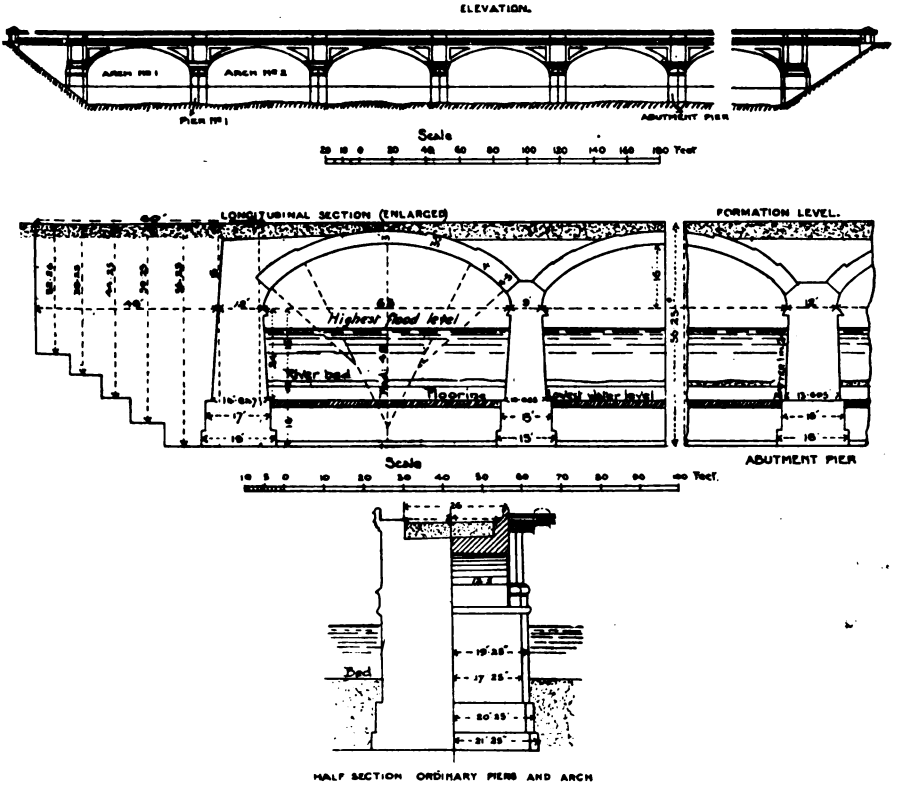

FIG. 2a.—*Sohan Bridge* ("*Roorkee Treatise on Civil Engineering*," Vol. II.).

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abutment is minimum. The resultant of T and W may now fall outside the bed joint F E, in which case the abutment will probably collapse as no faith can be placed in the strength of the shaken mortar in the abutment. In any case hair-cracks will appear in the mortar, moisture from the earth will penetrate these cracks and tend to lessen the weight W, and the whole replacement will be in a state of instability. Before any replacement of an arch bridge is decided on it is always necessary to make some calculation to determine the state of the forces acting on the abutments. These calculations though important in a single-span arch bridge are still more important when damaged viaducts are under consideration. To illustrate the point in question a concrete example is given. *Fig. 2a* shows a brick-arch bridge taken from an illustration in the Roorkee Treatise on Engineering. It is assumed that arch No. 2 in this bridge has been destroyed by the enemy and that the bridge has to be repaired so that the road will be open for a double line of motor traffic.

The span of the arch that has to be replaced is 63 ft. Suppose that the maximum load to be dealt with is a double row of Foden steam lorries. These lorries weigh 12 tons. Eight tons on the hind axle, 4 tons on the fore axle. Distance between axles 14 ft. Then the greatest load to be dealt with will be a double row of lorries spaced as in *Fig.* 3, *i.e.* actually a load of 24 tons on 63-ft. span or say 32 tons

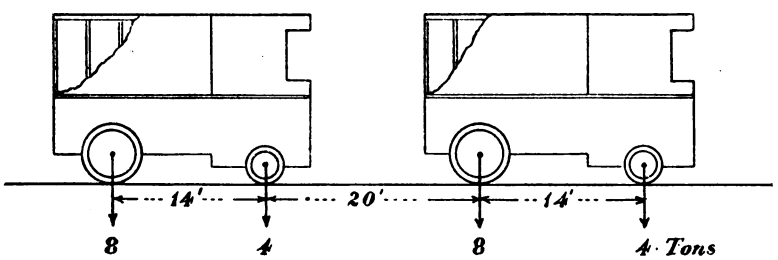

FIG. 3.

with the lorries a little bit more crowded. If the lorries were much closer than this their speed would be much reduced and the live load factor would be small. The actual live load per foot-run of the bridge for a single train of lorries will be $\frac{32}{63}$ tons, say $\frac{1}{2}$ ton per foot-run. The total equivalent dead load for a double train of lorries will be :—

$$2 \times 2 \times 63 \times \tfrac{1}{2} \text{ tons} = 126 \text{ tons.}$$

The roadway is 24 ft. broad, therefore the equivalent dead load per foot-super will be :—

$$\frac{126 \times 2240}{63 \times 24} = 190 \text{ lbs. per foot-super.}$$

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190 lbs. per foot-super may be therefore taken as the maximum load on the bridge. Consider the state of affairs supposing that the second arch from one end is blown down. In most cases of demolition the whole arch will disappear and there will be a gap of 63 ft. left between the first and second piers. This means that pier No. 1 is deprived of the arch thrust of No. 2 arch (see *Plate* I.). Pier No. 1 is therefore acted on by the minimum arch thrust of arch No. 1. That is the arch thrust due to the dead load on arch No. 1. For stability the resultant between the minimum arch thrust of arch No. 1 and the weight of pier No. 1 must fall inside the bed joint S T in pier No. 1. If this resultant falls outside the centre third of the bed joint S T there will be tension in the mortar on the left-hand face of pier No. 1. If the resultant falls outside the bed joint S T the upsetting moment on the joint S T will be greater than the stability moment and the pier will fail unless the tensile strength of the mortar is big enough to resist the overturning moment. To find the maximum resultant arch thrust caused by the dead load on arch No. 1 :—

For stability the line of resistance of the arch ring is made to fall somewhere inside the centre half of the arch ring itself, and also at some point the direction of the line of resistance must be horizontal. In this case the load on the arch being symmetrical the direction of the line of resistance will be horizontal at the centre of the arch.

We therefore know that if the arch is cut in two at the centre that equilibrium can be maintained by the application of some horizontal force and that the point of application of this horizontal force must be somewhere inside the centre half of the arch ring. To find the magnitude of this horizontal force, the dead load on the arch must be ascertained and for purposes of calculation it is convenient to represent this load by an area. Considering a slice of the bridge 1 ft. thick (see *Plate* I.) the total dead load on this slice for half an arch is the masonry in the area A B C D. Of this area the portion A E F G D is brickwork or brick filling weighing 110 lbs. per cubic foot and the portion B E F G C is sandstone weighing 130 lbs. per cubic foot. The area B C D A does not therefore represent the actual dead weight on the half arch but the area A H I D bounded by the equivalent dead load line does represent the actual dead load on half the arch.

The equivalent dead load line is obtained as follows :—

The length G D represents 17 ft. of brickwork at 110 lbs. per cubic foot.

That is G D represents 1,870 lbs. The actual length of G D is 4·54 in., *i.e.* 1,870 lbs. is represented by 4·54 in. and from this the scale of weights is worked out (see *Plate* I.).

The length C G represents 4·3 ft. of sandstone at 130 lbs. per cubic foot, *i.e.* 559 lbs. Measure off 559 lbs. from the scale of weights then I G represents this weight on the same scale as G D

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represents the weight of the brickwork and I is one point on the equivalent dead load line.

Other points are worked out in the same way and I H the equivalent dead load line is obtained. The area H I D A therefore represents the dead weight on one-half of the arch.

This weight can now be calculated. Divide the figures H I D A into 12 or more sections 1, 2.....12. The weights of each of them can be computed. For example the weight of section No. 1 is :— Average weight (scale this off the scale of weights) × breadth (measure off scale of feet) × 1 ft. (the thickness of the slice).

This works out to be 2,150 × 2 × 1 = 4,300 lbs. Section No. 2 weighs 3,640 lbs. and so on. Adding all these sections the total dead weight is 35,190 lbs.

The centre of gravity of the figure H I D A is now found and the weight 35,190 lbs. must act through this centre of gravity shown C G.1 on *Plate* I.

Considering half the arch ring cut off at A H. There are three forces acting on the cut-off portion.

(1). W the weight. The direction and magnitude of this is known.

(2). R the reaction at the abutment. The direction and magnitude of this is unknown but we know it must act between certain limits, *i.e.* between O and N, the centre half of the arch ring.

(3). H the reaction at the crown. This we know is horizontal and must act somewhere between M and Q, the centre half of the arch ring.

Taking moments about N. The lowest possible limit for R and putting H to act as high up as possible, *i.e.* H acting at M we obtain the equation

$$H \times 14{\cdot}5 = 35190 \times 12$$

or

$$H = 29120 \text{ lbs.}$$

Then from the triangle of forces since R, H, and W must meet at a point we obtain the direction and magnitude of R. This reaction R is the minimum arch reaction due to the dead load on the arch. The value of R being 45,600 lbs.

Considering No. 2 arch as demolished. No. 1 pier is therefore acted on by R and this force tends to upset No. 1 pier.

Combining R with the weight of the pier I R T S 48,640 lbs., we obtain R_1. R_1 being the resultant between the minimum arch thrust of arch No. 1 and the weight of pier No. 1.

R_1 is obviously exerting an overturning moment on pier No. 1 and pier No. 1 will overturn unless the mortar in pier No. 1 is strong enough to resist this overturning moment.

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To find the tension in the mortar at the bed joint S T. The resultant of all the forces acting on a 1-ft. strip of pier No. 1 is $R_1 = 88{,}600$ lbs. Treating this 1-ft. strip as a cantilever the bending moment at the joint S T is

$$88600 \times 7{\cdot}5 \text{ foot-lbs.}$$

The moment of resistance of the 1-ft. strip is $\frac{1}{6}rbd^2 = \frac{1}{6}r \times 100$ ft.-lbs. since the section of the 1-ft. strip is rectangular "b" being 1 ft. and "d" being 10 ft. long "r" being the resistance of the mortar.

Equating the moment of resistance to the bending moment we obtain

$$\tfrac{1}{6}r \times 100 = 88600 \times 7{\cdot}5..$$

Whence $$r = 39870 \text{ lbs.}$$

No consideration has yet been taken of the vertical component of R_1. This vertical component is 83,350 lbs. This will exert a compressive force on the joint S T 8,335 lbs. per square foot.

Therefore the maximum tension in the mortar will be 39,870 −8,335 lbs. per square foot or 220 lbs. per square inch.

While the maximum compression will be 21·5 tons per square foot.

If pier No. 1 is built in good P.C. mortar the safe tensile strength will be say 400 lbs. per square inch and therefore the pier will not overturn. There will however be a very small factor of safety especially as the pier will be shaken by the explosion that demolished arch No. 2. Any rolling load placed on arch No. 1 will increase the overturning moment in pier No. 1. What we now have to investigate is the effect on pier No. 1 when the full load covers arch No. 1 from I to the left.

The maximum arch reaction must first be found. The live load is put on from the weight scale and the total maximum load on arch No. 1 is represented by the figure K L A D. The centre of gravity of this figure is found in the same way as before. H_2 the horizontal reaction under this load is 36,900 lbs. and R_2 the maximum arch reaction is found to be 55,300 lbs.

R_2 is combined with the weight of pier No. 1 giving $R_3 = 97{,}000$ lbs. R_3 of course falls further outside the bed joint S T than R_1 and therefore the mortar in S T is under greater tensile stress than before.

The actual tensile stress in the mortar under the maximum arch reaction of arch No. 1 is 425 lbs. tension. The maximum compression being 29 tons per square foot.

This proves that even giving the mortar in the bed joist S T its full theoretical value, pier No. 1 is unstable under the maximum arch thrust of arch No. 1.

In any case whether the theoretical strength of the mortar is strong enough or not it is inadmissible to trust to the strength of mortar in structures of any importance. If the mortar is in tension hair-cracks will form in the face of the pier under tension and in this

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case since the piers are surrounded by water, this water will be forced under pressure of its own head into the hair-cracks thus increasing the tendency to overturn the pier.

Any scheme for the replacement of the demolished arch must be so arranged that the replacement shall exert a reaction due to its dead load only on pier No. 1 such that this reaction combined with the maximum arch thrust of arch No. 1 shall fall inside the centre $\frac{1}{3}$ of the bed joint S T.

Three ways of doing this are suggested.

(i.). Place a pile pier between masonry pier No. 1 and No. 2 and then put strutted beams between the piers (see *Fig.* 4). This is not practical, as to get a sufficient thrust on the masonry piers about 14 ft. of earth filling has to be placed on the strutted beams. This causes the point of application of the thrust in the struts to be too far down the pier.

(ii.). Strutting between piers. This does not seem practical, as the span is so large.

(iii.). Replace the masonry arch with a 3-hinged timber arch (see *Fig.* 5).

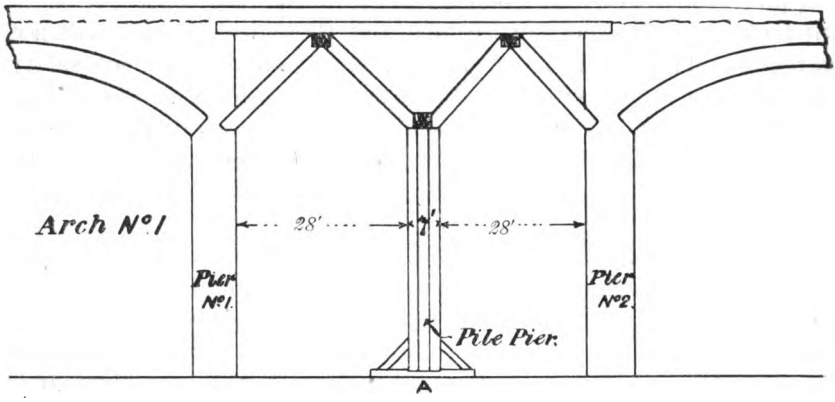

FIG. 4.

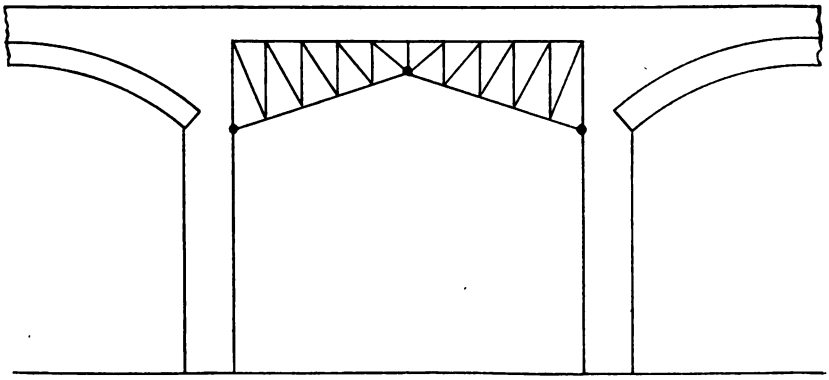

FIG. 5.

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Suppose this arch is as shown in outline U V W X (see *Plate* I.). The hinges being at V and U. Considering the arch as weightless (the weight of the arch will be small compared to the superimposed load) but loaded with earth filling as represented by X W Y Z we have three forces acting on the arch X W V U. Namely :—

(1). The horizontal reaction H_3 acting through the hinge V. Since the arch is symmetrically loaded the reaction at V is horizontal and since there is a hinge at V the reaction must go through it.

(2). W the weight of the filling X W Y Z.

(3). The resultant of these two forces which is the minimum arch thrust due to the braced arch X U V W and which must pass through U since there is a hinge there.

The problem is to make the weight of X W Y Z such that it will give when combined with R_3 (the maximum arch thrust of arch No. 1) a resultant R_4 which will fall inside the centre third of the bed joint S T.

Taking the earth filling over the braced arch to be as in *Plate* II., and considering the filling to weigh 130 lbs. per cubic foot. Considering a 1-ft. strip of the roadway the weight per foot-run on the braced arch is :—

$$4{\cdot}25 \times 130 \text{ lbs.}$$

or $$4{\cdot}25 \times 130 \times 31{\cdot}5 \text{ lbs.} = 17403 \text{ lbs. on the half arch.}$$

Taking moments about U

$$15{\cdot}7 \times 17403 = H_3 \times 11.$$

$$\therefore \quad H = 24839 \text{ lbs. (about).}$$

Drawing the triangle of forces we obtain the minimum arch thrust exerted by the braced arch. Combining this with R_3 we obtain R_4 the resultant of the maximum arch thrust of arch No. 1, the weight of abutment No. 1 and the minimum arch thrust of the new braced arch.

R_4 is found to be only just outside the centre third of the bed joint S T and the result is safe enough for all practical purposes.

A braced arch therefore has to be constructed of 63-ft. span. The roadway is to be 24 ft. wide and the filling on the roadway is to be 4·25 ft. of earth filling at 130 lbs. per cubic foot. The total dead load on the half span of the braced arch is therefore

$$4{\cdot}25 \times 130 \times 31{\cdot}5 \text{ lbs. or } 186{\cdot}5 \text{ tons (about).}$$

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Using six panels in the half arch the dead load will be 31 tons per panel point or say 32 tons per panel point to allow for the dead weight of the arch itself. This will give a near enough result to the true weight of the arch and the filling above it as 130 lbs. per f.s. for the filling is a fairly high figure. The total equivalent dead load due to the traffic may be taken as 200 lbs. per f.s. over the 24-ft. roadway, or roughly 11·4 tons per panel point.

Supposing that only one braced arch was used to span the gap the loading of this arch would be as in *Fig.* 6.

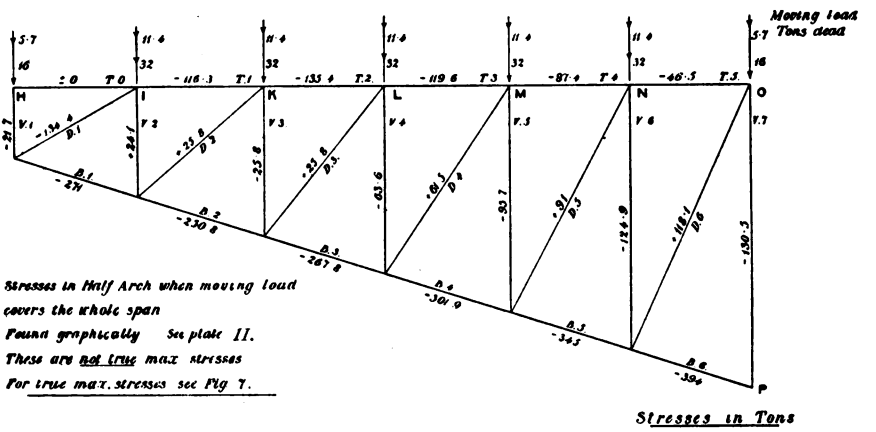

FIG. 6.

Plate II. shows how the stresses in the braced arch are found graphically when the moving load covers the whole bridge.

Fig. 6 shows the stresses in the various members of the arch under full load. These are obtained graphically. These stresses are not however true maximum stresses except in the case of T_0, T_1, T_2, T_3, T_4, T_5, V_7, V_1, D_6, D_1, and B_6. The remaining members are stressed to a maximum when the moving load is covering only certain panel points and are not stressed to maximum when the moving load covers all the panel points.

In this case however in order to obtain a minimum arch thrust on the abutment, equal to the minimum arch thrust of the demolished arch it has been necessary to load the new braced arch very heavily with a permanent dead load. This dead load is much larger than the moving load and therefore the moving load will not have any great effect on the stresses and in a case of this sort where speed is essential it would be safe to take the stresses found under full load as maximum stresses and work out the bridge accordingly. The true

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maximum stresses could be worked out afterwards and any corrections made.

It would not be safe to do this were the live load large and the dead load small, as in this case there would be certain to be reversal of stress in V_2, D_2 and the maximum stresses in B_1—B_5 will be larger than those found when the moving load covers all the bridge.

Fig. 7 shows the true maximum stresses set up in the structure as the load rolls over. These stresses are obtained by the method of sections. It will be seen from this that there is no reversal of stress in any member.

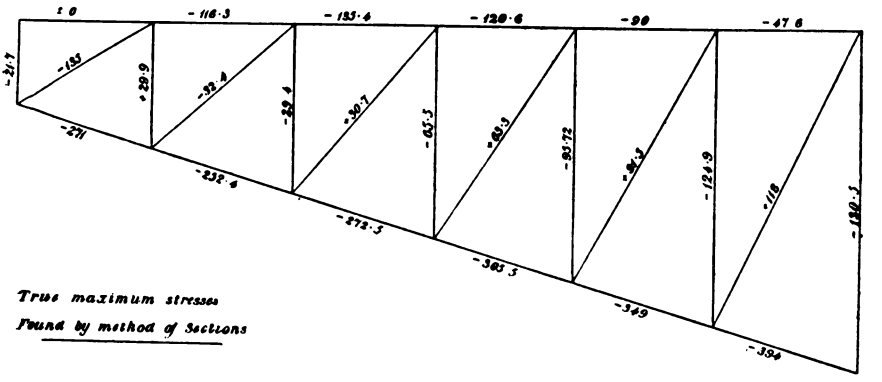

FIG. 7.

From the stresses in *Fig.* 7 it is possible to design a bridge that will carry the load required. Suppose 21 braced arches were made to carry the 24-ft. roadway then each arch would have to be designed to take $\frac{1}{20}$ of the stresses shown in *Fig.* 7.

There is no need to go into the actual design of the arch as it will be worked out as an ordinary timber and iron girder.

The hinges are formed by merely being butt joints of wood on wood. The central hinge may be formed of an iron pin the ends of the lower booms being shod with plate iron to take the pin. This can be seen in the photographs (1) and (2). This central hinge is really unnecessary as the shear at the central hinge cannot cause failure as one-half of the arch cannot slide on the other at the centre until the abutments give out.

It has been stated by many that the three-hinged braced arch is not practical in the field.

If this is the case what is the best method of repairing a viaduct when one span is blown in? Various suggestions have been made. It has been suggested that the bottom of the sloping struts in *Fig.* 5

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should be connected by horizontal struts, the duty of these horizontal struts being to help keep the viaduct piers in position. Another suggestion is to tie back the unsupported piers by cables passed back to anchorages. The three-hinged braced arch appears to be the quickest way of solving the difficulty as these arches are constructed quite as easily as ordinary timber girders. The photographs show a small 40-ft. span braced arch. Concentrated loads of 8 tons were hung on various parts of this arch but it showed no signs of distress. The arch in the photograph was provided with a central hinge consisting of a steel pin passing through iron plates. This hinge was calculated to take the maximum shear that could come on a girder of 40 ft. span. The hinge is really unnecessary provided the abutments are firm.

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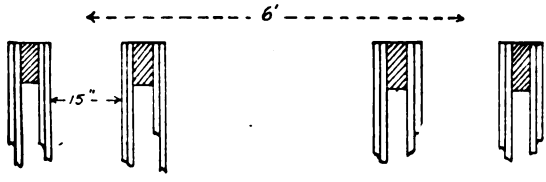
TIMBER GIRDERS.

By MAJOR R. H. CUNNINGTON, R.E.

THE attached has been worked out for timber girders of from 50 ft. to 100 ft. span. The table of dimensions and sketches may be useful as a check on calculations or where there is no time to make them.

GIRDERS TO CARRY A SINGLE HEAVY MOTOR LORRY.

(*Axle Loads* 17,700 *and* 7,100 *separated by* 13 *ft.*).

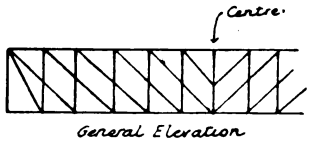


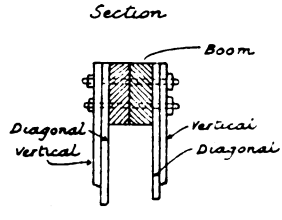
Use two girders under each wheel track, the centres of each pair to be 6 ft. apart, corresponding to width, centre to centre, of wheel track.

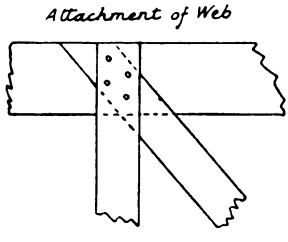
Girders under each wheel track to be 15 in. clear apart and braced together at intervals.

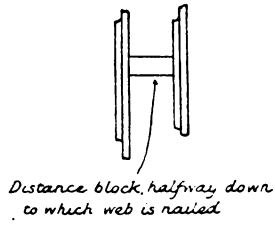
Deck, double row of 9 in. × 3 in. crosswise.

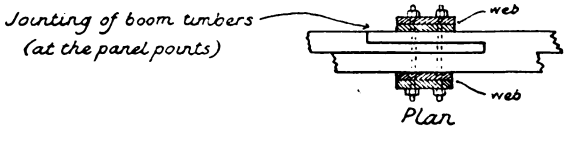
Wheel guides to be 7 ft. 4 in. apart in the clear to allow 8 in. play.











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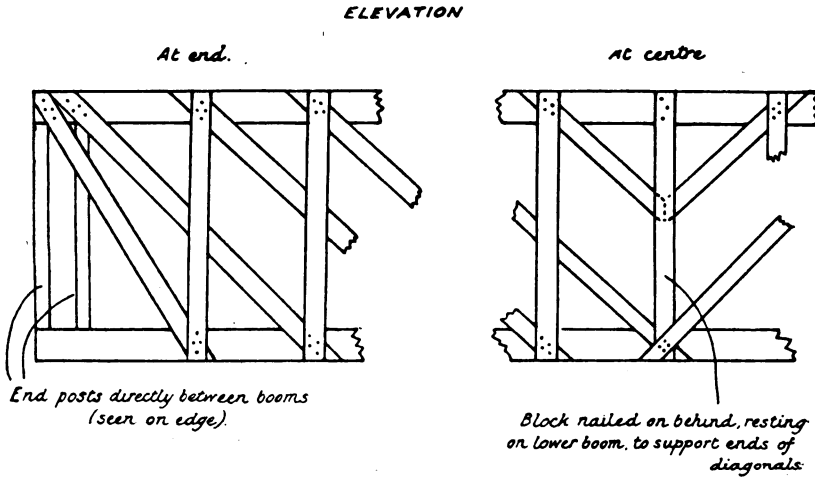

TABLE OF DIMENSIONS.

Clear Span. Feet.	Booms.	Web.	Height Centre to Centre of Boom. Feet.	End Part.	Web Fastening. Four Bolts. Diameter. Inches. (Screwed up tight).	Least Length of Boom Timbers. Feet.*	Weight of Girder. Lbs.
50	Two 9″ × 3″	6″ × 1″	5	Two 6″ × 3″	½†	22	2,700
60	Two 8″ × 4″ (or 10″ × 3″)	7″ × 1½″	6	Two 8″ × 3″ (or 6″ × 3″)	⅝	26	4,300
72	Four 9″ × 2″ or two 9″ × 4″	7″ × 1½″	6	Two 8″ × 3″	⅝	26	5,600
84	Three 9″ × 3″	7″ × 1½″	7	Two 9″ × ″3	⅝	23	7,600
96	Three 9″ × 3″	9″ × 1½″	8	Two 9″ × 3″	¾	26	9,600

* This allows 12 in. each end for halving. If shorter timbers are used, for every panel length they are short, four bolts are missed, which have to be specially inserted.

† An extra bolt is required for last five diagonals at each end of girder.

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SIEGES AND THE DEFENCE OF FORTIFIED PLACES BY THE BRITISH AND INDIAN ARMIES IN THE XIXth CENTURY.

(*Concluded*).

By COLONEL SIR EDWARD T. THACKERAY, V.C., K.C.B. (LATE R.E.).

THE SIEGE OF LADYSMITH.

The environs of Ladysmith lend themselves to a policy of pure defence far more readily than is generally supposed. The perimeter eventually held gave the defenders a clear field of fire for 1,400 yards and upwards along almost its whole extent.* Before October 30th, 1899, a series of fieldworks calculated for the defence of the town itself had been constructed by Major S. R. Rice, R.E., and these formed the basis, at any rate on the north-eastern side, of the defence scheme which was now formulated and put into execution. The whole perimeter was divided into four sections, A, B, C, and D, under the command of Colonel Knox, Major-General Howard, Major-General Ian Hamilton and Colonel Royston.

Section A extended from Devonshire Post, the easternmost of the kopjes on the northern edge of the Ladysmith Plain, to Cove Redoubt some 3 miles to the west. Devonshire Post, Helpmakaar Hill, Cemetery Hill, Tunnel Hill and Gloucester Post, to the east of the railway, were at the opening of the siege held by the Devons, half the 1st K.R.R., half the Liverpools, and the remnant of the Gloucesters. Immediately west of the junction of the Harrismith and Newcastle railways was Junction Hill, with a naval 4·7 gun guarded by two companies of Liverpools. The other 4·7 and the remaining two companies of the Liverpools were on Cove Redoubt, while the naval 12-pounders and the chief station of the Naval Brigade were between the two on Gordon Hill. This section had the smallest clear field of rifle fire, and was exposed to converging artillery fire from every quarter. But it was strongly manned, and its commander, Colonel Knox, had not been at Plevna in 1877 for nothing. Under his direction and by the willing exertion of officers and men, the open stone breastworks already in existence were improved, connected with a curtain of stone wall, and made accessible by covered ways, till eventually the whole section became one continuous fortification. The scrub on the plain in front of the eastern portion was cut down, and converted into three parallel lines of abattis, 100 yards apart. West of Knox came Howard's section manned by the Leicesters,

* On the north-east there was at one point cover to within 800 yards from the British trenches, and on the south-west a gap of only 900 yards separated Wagon Point from Mounted Infantry Hill.

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Rifle Brigade, and the bulk of the two battalions of the K.R.R. This section extended westwards from Leicester Post, past King's Post to Ration Post, along the north side of the valley in which the "tin camp" of the permanent garrison was situated, and then southward and south-eastward by Rifleman's Post to Range Post on the right bank of the Klip River. The northern face of this section was strongly fortified and practically continuous with A Section. On the western face the works were lighter and more isolated. This was even more the case with Hamilton's section, the longest and most weakly held of them all, which continued south-eastward from Range Post, past Highlanders Post, and Maiden's Castle up to Cæsar's Camp, the latter held by the Manchesters, and the other points by half the Gordons and the two surviving companies of the Irish Fusiliers.

From halfway down the slope of Cæsar's Camp to Devonshire Post the plain was picketed and patrolled by the Natal Volunteers, under Royston. A proportion of the artillery was assigned to each section. The most powerful weapons of the defence were the naval guns, posted along the northern portion of Knox's section. In addition Helpmakaar Hill and Devonshire Post were strengthened by the inclusion in their system of works of the field guns of the 13th Battery and of two 6·3 howitzers of obsolete pattern which had been sent round from Port Elizabeth at White's request. Although these guns had only a range of some 3,000 yards they proved of signal service throughout the siege and kept down the fire of any gun which the enemy pushed within their range. The 42nd Battery was sent as soon as a practicable road was made to Cæsar's Camp, and posted in sections in skilfully designed pits along the main plateau. The 69th Battery was held in support of Howard's section of the defences. The remaining three batteries—the 21st, 63rd, and 67th—together with Brocklehurst's cavalry brigade and half the Gordons were kept as a central reserve. These dispositions and the composition of the reserve were however considerably varied in the course of the siege. A very complete system of telephonic communication was established between the different posts and Sir G. White's headquarters in Ladysmith. The total length of the perimeter was about 14 miles, and the force available for its defence amounted, inclusive of the reserve, to over 13,000 men.

The details of the force in Ladysmith were as follows:—

Naval Brigade.—Two 4·7-in., four 12-pounders, four Maxims, 284 officers and men; Natal Naval Volunteers.

Mounted Troops.—6th Dragoon Guards, 5th Lancers, 18th and 19th Hussars, Natal Carabineers, Natal Mounted Rifles, Border Mounted Rifles, Natal Mounted Police, Imperial Light Horse; about 2,800 men.

Royal Artillery.—13th, 21st, 42nd, 53rd, 67th, 69th Batteries, R.F.A.; four 15-pounders, two 6·3 howitzers, two 12½-pounders (captured at Elandslaagte), two 9-pounders (No. 10 Mountain

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Battery), two 3-pounder Hotchkiss (Natal Hotchkiss Detachment), Ammunition Column.

Royal Engineers.—23rd (Field) Company, Balloon Section, Telegraph Section.

Infantry.—1st Liverpools, 1st Devons, 1st Gloucesters, four companies 1st Manchesters, 1st and 2nd King's Royal Rifles, Royal Irish Fusiliers (two companies), 1st Leicesters, 2nd Gordons, 2nd Rifle Brigade, 2nd Dublin Fusiliers (half-company); total over 6,000 men.

Army Service Corps and Army Ordnance Department.

Town Guard about 250 men.

The Battle of Ladysmith had created for the Boers an opportunity to inflict a crushing blow on their enemy, such as was never to present itself to them again. With nearly 22,000 men concentrated round White's shaken and dispirited force, they might with every prospect of success have attempted to rush Ladysmith during the first day or two after the battle, when it was still practically unfortified. But such an attempt, involving both promptitude of decision and a readiness to face heavy losses, was foreign alike to the cautious character of General Joubert and to the constitution of the force which he commanded. With the deliberation which had marked the whole of their invasion of Natal, the Transvaalers confined themselves on October 31st to occupying the eastern edge of the Ladysmith plain, not so much to secure positions for a further offensive, as to utilize the immunity from attack thus assured in order to settle down in their laagers and discuss the situation in comfort. The Free Staters similarly settled down with their main body to the north-west of the town. That evening, however, General A. P. Cronje led out some 2,000 men of the Harrismith, Heillbron, Winburg and Brede Commandos, with two guns, and by a night march across the open plain west of Ladysmith established them in the hilly ground to the south-west where they would be conveniently posted either to check an attempt on the part of the British to break out on that side, or to cross the hills and descend upon Colenso, into which place they in fact began to drop shells a few hours later.

On November 1st a joint council of war was held at Joubert's headquarters when it was decided that the commandos should invest the town on all sides to prevent the escape of White's force, while their artillery carried on a bombardment which it was confidently expected would bring about a surrender before the end of many days. The different sections of the investing line were duly apportioned, gun positions were selected, and during the next few days the burghers busied themselves in putting their policy into execution. In this they were not seriously disturbed by the British who were too preoccupied with the task of strengthening their own defences to attempt to take advantage of the confidently negligent movements of the commandos. The cavalry reconnaissance of November 2nd did indeed succeed in surprising the Winburgers; but that of the

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Imperial Light Horse on the 3rd, developing as it did into an inconsequent general engagement, only seemed to encourage the burghers, who greatly enjoyed shelling the British back into camp, and believed that they had repelled a determined attempt to break through the investing line with very trifling loss to themselves.

The positions taken up by the Transvaalers for the investment were, with small modifications, those in which they had encamped on their first arrival and from which they had fought on October 30th. Joubert's headquarters were behind Long Hill, a little distance south of the railway siding at Modderspruit, which was now converted into an advanced base for the whole Transvaal force round Ladysmith and subsequently on the Tugela. Here, the commissary-general established his supply park, and separated from the British positions by the valley through which runs the Harrismith Railway was General Erasmus's section, 3,500 to 4,000 men in all. The centre of the Transvaal position was under Vice-President Schalk Burgen, Joubert's second in command, and was manned by some 6,000 to 6,500 burghers. Behind Lombard's Kop and Lombard's Nek were the strong Middelburg and Heidelberg commandos. The southern section was held by Lukas Meyer, temporarily replaced by Louis Botha, with some 4,500 burghers. Wakkerstrom, Krugersdorp and Standerton were securely camped behind Balwana and Interbagone. Utrecht, Vryheid, and the Pretoria Germans, in the order named, held the ridges across the Klip river facing the plain, and Cæsar Camp with their laagers in the valley of Herman's Spruit. The rest of the circle was completed by some 7,000 or more Free Staters. The head laager under Martinus Prinsloo with part of the Winburg commando, was at Smith's crossing on the Harrismith Railway. The large Kronstadt commando, laagered in several camps, held the line eastwards to Thornhill's Kopje adjoining the Pretorians on Surprise Hill, and south-westwards to the Sand Spruit, including the ridge crossed by the telegraph line from Ladysmith to the Free State and known to the besieged as Telegraph Hill. South, Harrismith held Lancers Hill, commanding the road from Potgeiters Drift, and the Long Valley across to Middle Hill, while beyond them the burghers from Ventenburg and Winburg, on the extreme right, kept touch with Vryheid and the Germans on the Transvaal left.

The whole of these positions were admirably adapted to the work intended to be accomplished, which was not so much to facilitate the capture of Ladysmith as to prevent the escape of the garrison. The broad valleys around Ladysmith were as defensible from one side as from the other, and furnished the Boers with an outer circle of defences corresponding exactly to the perimeter held by the British garrison. By their dispositions the Boers, no less than Sir Geo. White, made all transition from the defensive to the offensive difficult for themselves, and thus prepared for the long and weary stalemate of the siege.

The Boers placed the greatest confidence in the speedy and complete

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success of the artillery bombardment. The available guns some 17 in number increased afterwards to about 22 were dragged up under Colonel Trichardt's directions on to the various heights commanding the town on the British defences. These included two 6-in. Creuzot "Long Toms" firing a 96-lb. projectile with an effective range of nearly 10,000 yards, and four 4·7-in. Krupp howitzers, firing a 34-lb. projectile with a range of over 6,000 yards. For the rest, the Boer siege artillery consisted of their ordinary Krupp or Creuzot guns. A comparison of the gun power of besiegers and besieged is instructive, for it brings out the fact that, except in long range weapons, the Boers were less than half as strong as the enemy whom they were attempting to reduce. This inferiority prevented their bringing their field guns into effective range, and threw practically the whole task of bombardment on the long-range guns. Even with a very small target and a carefully concentrated fire it would be difficult to hope for much result from the fire of half-a-dozen guns. But so elated were the Boers by the success of "Long Tom" in driving Yule out of Dundee, and by the more recent prowess of the Pepworth guns on October 30th, that they attributed a well-nigh magical efficacy to the bombardment, convinced that it would force White into almost immediate surrender.

The bombardment may be said to have begun on November 2nd, when the Creuzot on Pepworth opened a desultory fire first on the town and then on the naval 4·7, which had just been mounted on Junction Hill, one of its shells mortally wounding Lieut. Egerton, R.N., in command of the gun. That same evening other guns joined in from Lombard's Nek, and on the 3rd and 4th the bombardment increased in intensity as new guns were brought into position. Trifling as the fire was from the military point of view, it induced the mayor to address Sir Geo. White on the removal of non-combatants, more especially of women and children, to some place of greater security. The principal medical officer also pointed out that the sick and wounded in the Town Hall, which had been converted into a hospital, were exposed to grave danger from the fire. The result was the opening up by White of negotiations with Joubert which resulted in an armistice till midnight on the 5th and the formation of a neutral camp for sick, wounded, and non-combatants at the southern end of the plain along the Intombi Spruit. Trains were run down to Intombi on the 5th, hospital tents pitched, and before the armistice expired most of the sick and wounded were transferred to the new camp. The camp was placed under the control of Mr Bennett, the Resident Magistrate of Ladysmith, while Major Mapleton, R.A.M.C., was made responsible for the hospital arrangements. Under agreement with the besiegers, a daily train was allowed to ration the camp, provided it made the journey in daylight.

The armistice was actively employed, alike by the British in strengthening their positions, and by the Boers in mounting and

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protecting their guns. With much labour the second "Long Tom" which now arrived from Lang's Nek, was dragged on to the summit of Bulwana, and on the morning of the 8th opened fire, at a range of 7,500 yards, from a projecting spur on the west side of the hill—to the great consternation of the Ladysmith staff, who had never anticipated such a feat of gun transportation, and now found many of their defences enfiladed or taken in rear by its far-ranging and alarming projectiles. Meanwhile a week had passed since the opening of the bombardment, and to the surprise and chagrin of the Boers there were no signs of surrendering from Ladysmith.

A Krygsraad was held on the 8th, and it was agreed that the policy of investment should make way for one of active offence which should place the Boers in possession of some point commanding the town and the British positions at closer range.

The obvious key of the whole position was the great ridge of Cæsar's Camp, and Wagon Hill, known to the Boers as the Platrand which with its northern underfeature, Maiden's Castle, completely dominated the whole of the town, and of the western defences at from 2,000 to 5,000 yards range. Another point known to be weakly defended and not trenched whose occupation would seriously cramp the defences of the garrison was Observation Hill, a ridge some 1,700 yards in front of Cove Redoubt and separated by a valley only 1,400 yards across from the bush-grown plateau of Bell's Kopje held by Van Dam's "Zarps." It was decided not to waste a single day but to capture the Platrand and Observation Hill by a sudden attack that very night.

The commandos along the sections opposite these points were warned to start soon after midnight; the rest were to support or assist by a demonstration in the morning under cover of a grand bombardment. Late at night the attack on Cæsar's Camp was suddenly countermanded, for on reconsideration of the plan from his own standpoint Joubert thought this part of it too venturesome. The rest of the plan held good, and at 1.30 a.m. on the 9th Field-Cornet Zeederberg's section of the Pretorians left their laager and established themselves by daybreak in a donga within 800 yards from Observation Hill. Had they come a little earlier they could have pushed on at once and could have occupied the hill itself without opposition.

At 5 a.m. all the Boer guns began the artillery preparations for the attack, that is to say, they dropped their missiles into the town, the tin camp, and on to different points of the defences according to the gunners' fancy. An hour later the squadron of the 5th Lancers which as usual took up its position on Observation Hill at daybreak, was heavily fired at by the Pretorians, who were now advancing from the donga. Two companies of the Rifle Brigade were sent forward in support from Leicester Post, being shelled in rear from Bulwana as they reached the hill, and forced by this fire to send forward their exposed supports in order to prolong the more sheltered

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firing line. The advance of the Pretorians had already been checked by the fire of the Lancers who had held their ground manfully, and the Riflemen now effectually drove back the Boer supports, who were coming on from Bell's Kopje in considerable numbers, but with no great resolution. Firing was heavy all day but the attack was never pressed, though a small party of the Pretorians remained till dusk in the donga, and even behind rocks and out-hills some distance in front of it where the road ran close under Gun Hill. Before coming to this the force halted. Leaving 100 of the Border Mounted Rifles across the road to guard the left flank, and sending Royston with the main body of his Volunteers to the right to check any counter-attack from Lombard's Nek, Hunter with the storming party (the Imperial Light Horse and 100 Natal Volunteers of various corps) struck straight across the stony donga, intersected with thorn scrub, for the middle of Gun Hill. Arriving at the foot of the hill at 2 a.m., the assaulting column deployed into line; the Light Horse under Colonel A. H. Edwards and Major Kani Davies on the left; the Natal troop under Major Addison on the right. Then the ascent of the 250 ft. of steep boulder-strewn slope began. Slowly and steadily the men scrambled up what seemed an endless black wall of perpendicular rock. Suddenly from the darkness to their left rear came a faint uncertain challenge—"Wie daar?"—repeated again and again, and then with a sudden realization of what was happening, rising into an agonised cry of warning to the sentry on the summit: "Schiet, Stephanus, hier kom de verdomde rooineks, schiet, schiet!" With that the whole picket fired wildly into the rear of the assaulting line, which was clambering on with silent, desperate energy, and was now within 20 paces of the summit. A fringe of fire broke out along the crest, for the defenders had waited for them. A few men began to reply, but the officers stopped them, and then Edwards' voice ran out clear—"Fix bayonets!" There were no bayonets, but taking up the cry the men rushed the skyline. The thought of the cold steel was too much for the Boer gunners who fled into the darkness. At the head of his men Edwards groped his way across the plateau to the battery, annexing "Long Tom" in the name of the Imperial Light Horse. The 4·7 howitzer was found soon after, and then Capt. Fowke, and Lieut. Turner with a few sappers, inserted the guncotton charge into the breech and muzzle of the guns while the stormers withdrew from the crest. Then followed the explosion leaving the guns as the Sappers thought wrecked and irreparably destroyed; but they had yet to reckon with the resources of the Pretoria repairing shops.* Hunter called for three cheers for the Queen and then the descent began, the men taking with them as

* "Long Tom" was repaired within three weeks, and. with shortened muzzle and a new breech, was sent off to help in the Siege of Kimberley. The howitzer was beyond repair but an exact reproduction was made of it.

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trophies the breech-block of the 6-in. gun, and a Colt gun, and many other articles found in the battery. The return journey was unmolested. The total casualties were seven wounded, including Major Henderson to whose leading the success of this most gallant enterprise was so largely due.

Encouraged by the successful issue of the Gun Hill sortie Colonel Metcalfe asked and received permission to take out the Rifle Brigade on the 10th to destroy a 4·7 howitzer which had been pounding all the northern posts from Surprise Hill. At 10 p.m. five companies of the Rifle Brigade moved out of camp behind King's Post. Colonel Metcalfe was in command accompanied by Major King, R.A., the guides Thornhill and Ashby, and by Lieut. Digby Jones, R.E., in charge of the blasting detachment. The darkness was illuminated at intervals by the faint flicker of a flashlight on the broken clouds—they were signalling from the relief column 20 miles away. Then a harsher light would shine out from the enemy's position on Telegraph Hill, but the riflemen lay quietly in the nullah, the great beam left them undiscovered. At times there would be a rifle-shot in the distance, and perhaps a burst of firing, as some picket along the far line of defences imagined itself disturbed. But with the assaulting party all was still. Just before midnight the moon was lost in a bank of cloud, and the time for action had arrived. Silently the five companies of the riflemen filed out of the nullah and began slowly and steadily to pick their way across the uneven surface of the plain. Leaving half a company to protect their left as they crossed the Harrismith Railway, and another on their right in the shadow of Bell's Kopje, they moved on, every moment expecting to stumble on a picket, but finding none. Fortune was on their side, for till a few days before, a rise half a mile in front of Surprise Hill had been occupied nightly by a strong picket.

But Viljoen who had been responsible for that sub-section of the perimeter, had been withdrawn to the Upper Tugela, and his successor had not seen fit to continue his precautions. By 2 a.m. the foot of the hill was reached. Here two companies were halted and formed outwards to support the two other companies which furnished the assaulting line. The ascent now began, the boots and rifles of the men clattering audibly on the loose boulders of the slope. Yet it was not until the leading section was almost on the brow of the hill that the challenge came, and with it a burst of fire from the left shoulder of the hill. Heedless of the fire the Riflemen swarmed over the crest line. The battery was found in a few seconds, but for a moment the men thought their prize had been removed, until they unearthed it, covered with a tarpaulin, just outside the emplacement. The men were thrown out in a semicircle while the preparations for the destruction of the gun were made. When all was ready the party retired over the edge. But something went amiss with the fuze and Digby Jones returned to place another. This time all went

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well and after a ringing cheer the men started stumbling and slipping down the slope.

At the first outbreak of fire a Boer gunner on Bell's Kopje fired off a round to give the alarm, and in a few minutes the Transvaalers on that side, and the Free Staters at Thornhill's Kopje, streamed out of their laagers, and began firing furiously and blindly at the hill slope from both flanks. Through this fire, enveloping them at closer range every moment, the men stumbled down. Suddenly a ring of flame blazed forth at their very feet; a small party of Pretorians had boldly come round the side of the hill, and regardless of the heavy fire from their own side, had laid down in a line across the slope ready to intercept the storming party, of whose numbers they probably had no idea. But with implicit obedience to Metcalfe's orders, and disregarding the misleading orders shouted out by the Boers, the men charged forward in grim silence. The gallant band of Pretorians wildly emptied their magazines in the vain endeavour to stay the rush and then the Riflemen surged into and over them, killing or wounding several with their bayonets as they passed. From the foot of the hill the men, as arranged, made their way back as best they could under the lee of Observation Hill, getting home to camp by dawn. The casualties, 14 killed or mortally wounded, including Lieut. Fergusson, and 50 wounded were not excessive for a feat so gallantly and successfully performed.

The success of the sortie had a most inspiriting effect on the garrison, which was beginning to feel the depressing influence of inactive isolation. To the besiegers, who had gradually become more and more careless in carrying out the ordinary military precautions, the sorties were a severe shock.

The indignation in Pretoria over the Gun Hill affair was intense. The government censured General Burger, who was in command, and he ordered a court-martial, the sentence of which suspended Commandant Weilbach and Major Erasmus of the Artillery from their commands. The second sortie led colour to the suggestion now made that the unfortunate sentries—men of English names as it happened—had been guilty of deliberate treachery. They were arrested and sent to Pretoria, but eventually released.

The time appointed by Buller for the beginning of the relieving movement was now drawing near, and with it White's hopes of achieving some really effective stroke in the way of co-operation steadily grew. On December 9th Buller announced that he would start for Potgieter's on the 12th and would reach Lancer's Hill on the western edge of Long Valley by the 17th. On the 11th on the ground of being uncertain as to dates, he suggested that White should not attempt co-operation before he himself got to Lancer's Hill, unless he felt absolutely sure as to Buller's whereabouts. On the 13th the Potgieter's route was abandoned for Colenso and Ouderbrook Spruit and the date for the move postponed to the

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17th. Impressing upon his chief the all-importance of time as a factor of co-operation, and the necessity of keeping him informed of any change of plans, White set about his preparations. The mobile column was again brought into being. To free some of Royston's mounted troops for this work the town guard was on the 12th once more embodied. Some of the artillery was brought into camp from the defences, whilst a 4·7-in. gun and a 12-pounder were transferred from the northern defences to Cæsar's Camp and Wagon Hill. Arrangements were made for the feeding of Buller's force and the care of a large number of wounded. The special field force created by White's order of the 14th, which he intended to lead out in person, included almost all the best troops in Ladysmith, and left the merest skeleton of about four battalions, one battery, a cavalry regiment and a few volunteers to Colonel Knox for the defence of the town. For the first time since October 30th, White was determined to strike a blow with all the weight that he could put into it.

On the 15th Ladysmith woke to the noise of the fighting on the Tugela, but it was some time before White realized from the heliograms coming in, that Buller had anticipated the date fixed for the attack by two days without giving him warning. Even then White may have thought that Buller had good reasons for not calling in his aid until he had secured a footing across the river. Assuredly the summons to action would come in the morning.

The message, inexplicable and bewildering, came. As the actual text of the message has been made public it is here reproduced :—

BULLER TO WHITE.—No. 88 Cipher, 16th December :—" I tried Colenso yesterday but failed ; the enemy is too strong for my force, except with siege operations and those will take one full month to prepare. Can you last so long ? If not, how many days can you give me in which to take up defensive positions ? After which I suggest your firing away as much ammunition as you can, and making best terms you can. I can remain here if you have alternative suggestions, but unaided I cannot break in. I find my infantry cannot fight more than 10 miles from camp, and then only if water can be got, and it is scarce here.—Buller."

BULLER TO WHITE.—No. 92 Cipher, 16th December :—" My message No. 88 Cipher. Groups 31 to 43 were correctly sent, but in place of them, and first number of 44 group read as follows : How many days can you hold out ? Also add to the end of message : ' Whatever happens recollect to burn your cipher, and decipher and code books and any deciphered messages.'—Buller."

WHITE TO BULLER :—" Your No. 88 of to-day received and understood. My suggestion is that you take up strongest available position that will enable you to keep touch of the enemy, and harass him constantly with artillery fire, and in other ways as much as possible. I can make food last for much longer than a month, and will not think of making terms until forced to. You may have hit

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enemy harder than you think. All our native spies report that your artillery fire made considerable impression on enemy. Have your losses been very heavy? If you lose touch of enemy it will immediately increase his opportunities of crushing me, and will have worst effect elsewhere. While you are in touch with him, and in communication with me, he has both of our forces to reckon with. Make every effort to get reinforcements as soon as possible, including India, and enlist men in both Colonies who will serve and can ride. Things may look brighter. The loss of 12,000 men here would be a heavy blow to England. We must not think of it. I fear I cannot cut my way to you. Enteric fever is increasing alarmingly here. There are now 180 cases all within last month. Answer fully; I am keeping everything secret until I hear your plans."

The besieged garrison, ignorant of the inner story of Colenso, received the news with some depression, relieved by the cheerful tone of White's manly order, and by a calm consideration of the position. The defences had now been perfected and seemed practically secure against attack. Sickness was the worst enemy. There was food yet which with economy would last for two months. The most serious anxiety at the moment was the welfare of the horses. The supply of hard forage was almost exhausted. In fact in this respect the turning-point in the condition of the garrison had arrived. Up to December 15th it might have been used as a mobile force operating from its entrenched positions; after this date it gradually ceased to be anything but a garrison to the perimeter it held. From December 15th to the end of the year little occurred. The inconveniences of the siege were however brought home to the garrison more severely than heretofore. Supplies had to be husbanded and the scale of rations was reduced all round. The Boer artillery practice improved somewhat, and there was an increase in the casualties from this cause. Sir George White was forced to change his headquarters owing to the damaging fire directed upon his house, which lent some colour to the suspicion that the Boer gunners on Bulwana had information supplied to them from within the perimeter. Christmastide was not marked by any special development. Few of the festivities which mark the season were possible; but an impressive service was held by the Rev. J. G. W. Tuckey, Army Chaplain, and in the evening, Colonel Frank Rhodes, Colonel Dartnell, Major Doneton, and Major Kani Davies gave a Christmas party to the children of the garrison, an incident of pathetic interest amid the privations and anxieties of the siege.

On the morning of December 17th Lord Roberts received the news of his only son's death at Colenso. A few hours later at the call of duty he put his great sorrow behind him, and undismayed by the difficulty of the task, undeterred by the weight of his years, accepted the command of the forces in South Africa, conscious of his fitness to hold it, and to restore victory to the British arms. On December

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23rd, a dreary winter day, the new Commander-in-Chief for South Africa left Southampton, and at his request Major-General Lord Kitchener of Khartoum was appointed Chief of Staff. At the moment of his appointment Kitchener was at Khartoum engaged in the task of building a new city, and creating a new administration on the ruins of the Dervish power, the last remnants of which had been crushed by his lieutenants. Leaving Khartoum on the 18th December, he reached Alexandria on the 21st after three days by steamer and train, was there taken on board by the steamer *Isis*, and joined Roberts at Gibraltar on the 26th.

As his Director of Intelligence, Lord Roberts took with him Major G. F. R. Henderson, at that moment Professor of Military History at the Staff College. A brilliant writer and a profound thinker on the great problems of strategy and tactics, Henderson was an officer who would have risen to the highest positions on the General Staff.*

Colonel W. G. Nicholson,† an officer of exceptional capability and of great experience of staff work, whose cautious critical judgment and skilled pen Lord Roberts had long learned to value in India, was another member of the Staff. It was from India where he was occupying the post of Adjutant-General that Roberts now summoned Nicholson to meet him at Cape Town. Originally appointed as Military Secretary, he was subsequently entrusted with the direction of the transport service, and on a variety of responsible and confidential duties.

On the south side Joubert had intended that there should be nothing more than a demonstration. But the Vryheid burghers, acting on their own initiative, endeavoured to convert this into an actual attack, and securing a lodgment in the bush-grown underfeatures of Cæsar's Camp, and in the valley between it and Wagon Hill, pushed forward with some vigour about 10 a.m., being supported by a hot fire from Mounted Infantry Hill, and from other points. But the Manchesters, who had been strengthened by the arrival of the 42nd Battery and by some 130 of the Imperial Light Horse, who occupied Wagon Hill, replied strenuously, and the attack soon died away into an exchange of long-distance rifle fire.

By mid-day Sir G. White was so satisfied that he had nothing to fear from the attack that he was able to order a salute of 21 guns to be fired in honour of the Prince of Wales' birthday. Artillery and rifle fire went on until evening put an end to a rather tame sequel to the resolutions formed by the Boers on the previous day. The total casualties of the day were 4 killed, and 27 wounded on the British side, and probably about the same on that of the Boers.

* Colonel Henderson died in March, 1903, leaving a gap in the ranks of British military thinkers which will not easily be filled.

† Now Field Marshal Lord Nicholson, G.C.B. Nicholson reached Cape Town on January 18th.

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The direct result of this affair was that White's attention was drawn to two particularly vulnerable portions of his defences, and from this date Observation Hill, and eventually Wagon Hill, were included in the perimeter and scheme of the defence.

The moral effect upon the staff and the garrison generally of the weakness of the Boer attack was excellent, and did much to remove the depression which had weighed upon the whole force since the battle of the 30th. As for the Boers, their expectations of speedy results from the bombardment were no longer high as at first; but, on the other hand the reports of Kaffirs, caught in trying to make their way out, now led them to hope that famine and disease were already working fearful havoc with the garrison, and that the end could not be very far off. Meanwhile, as a concession to the clamour of the party of action, an expedition was organized for the invasion of Natal, south of the Tugela, and the first step taken was the reduction of the investing force which was gradually to bring it down to a mere skeleton of 5,000 to 6,000 men. Joubert himself accompanied the expedition to ensure its being conducted with due caution, leaving the command at Ladysmith in the hands of Schalk Burgher.

The departure of the Estcourt expedition on November 13th did not pass unobserved by the British outposts, and encouraged by this, and by the inactivity of the Boers since the 9th, White determined to essay a more active policy. On the 14th Brocklehurst went out with the 5th Lancers, 19th Hussars, two squadrons each of the Imperial Light Horse, and Border Mounted Rifles, and two batteries, with instructions to turn the enemy off Rifleman's Ridge. The Imperial Light Horse established themselves on Star Hill, north-east of Rifleman's Ridge, and the rest of the force endeavoured to work round by Field's Farm. The Boers on the Ridge, some 400 Trede and Bethlehem burghers, defended themselves vigorously, while three Boer guns joined in from different points. The British guns expended a great deal more shell than could be afforded for anything but a decisive operation, but no attempt was made to push home an attack which in the opinion of spectators from Wagon Hill might easily have succeeded, and early in the afternoon Brocklehurst withdrew. His withdrawal was a signal for a hot shell fire, in which Bulwana joined as the retreating force came within range.

From this date to the end of the month no incidents of great importance occurred to break the monotony of the investment. The bombardment continued as aimlessly as before. On the 14th and for a night or two after, the Boers fired a few rounds from their big guns in the middle of the night, a most harassing manœuvre, but one which they were too indolent to keep up. On the 23rd a single shell from Bulwana killed and wounded 11 men of the Liverpools on Junction Hill. On the 24th the Boer guns on Rifleman's Ridge and Telegraph Hill stampeded a herd of 228 oxen, and by a series of shells planted just beyond them, successfully shepherded them into their

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own lines. The direct result of this incident was the reduction of the Ladysmith meat ration on the 25th.

On November 27th the Boers unmasked a third 6-in. Creuzot on Middle Hill, bringing Wagon Hill and Cæsar's Camp under fire at a damaging range. To meet this new development the two old howitzers on Devonshire Post were removed by night, and mounted on the nek between Wagon Hill and its extreme spur, Wagon Point. They set to work to such good effect on the 30th that in a few rounds they completely mastered the fire of the "Long Tom," a lucky shot killing and wounding nine of the gunners and damaging the gun. It was withdrawn during the night, to reappear on December 11th on Telegraph Hill, whereupon the howitzers were sent round to Ration Post. At the increased range (4,000 yards) they were less successful, and never managed completely to silence it, and to the end of the siege it continued to shell the tin camp and northern defences. On the British side almost the only minor active measure undertaken at this time was the sending out one night of a locomotive containing some explosives up the Harrismith line in the hope that it might run into something. It successfully ran into the veld, where it overturned, its fate providing the garrison with many humorous sallies at the expense of the staff.

All this time Ladysmith had been in intermittent touch with the outside world by native runners. Maps of Ladysmith and the surrounding country, photographically reduced, were sent down to Maritzberg by carrier pigeons, and in this way Major Altham, White's A.A.G. for Intelligence, was able to give substantial help to the forces collecting south of the Tugela. On the 27th White announced his intention of harassing the commandos that were now being withdrawn to oppose Methuen, and of breaking a gap in the Boer line; a scheme which had to be abandoned owing to the coincidence of the Boer reinforcement of Rifleman's Ridge.

On the 30th in answer to Buller's inquiries, White announced that he still had 70 days' provisions and could hold Ladysmith while they lasted. On the 7th Colonel Knox was instructed to take out a small force that night and harass the enemy at Limit Hill and further along the Newcastle Road. Knox reported to Hunter that there were no Boers within reach in that direction, and suggested as an alternative an attack on Gun Hill, which since the removal to it of the Pepworth Creuzot had made itself very obnoxious to Knox's section. Hunter took up the idea warmly, and Sir G. White's sanction was secured on the condition that Hunter personally conducted the expedition and that at least 500 men accompanied him. Hunter selected for this bold enterprise 100 of the Imperial Light Horse, and 400 of Royston's Volunteers, entrusting the guidance of the force to Major David Henderson and his corps of Guides. Knox, whose previous orders still held good, was to cover the left flank of the sortie.

Preparations were made with the utmost secrecy, and at 10.15

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p.m. the little force started from Devonshire Post, marching along the road that leads round the northern slope of Gun Hill and Lombard's Kop. There was a Boer picquet, of whose existence Henderson was well aware, on a small spur.

This completes the narrative of the Siege of Ladysmith and of the situation at the close of the year 1899, and as this short compilation of the History of Sieges only extends to those that took place during the 19th century it is not proposed to narrate in detail the final operations of the siege which terminated in the relief of Ladysmith by General Sir Redvers Buller on March 3rd, 1900.

The memorable attack by the Boers on Wagon Hill; the charge of the Devons; the operations on the Upper Tugela; the ineffective attack on Spion Kop and its abandonment; the feint attack and capture of Vaal Krantz; the operations on the Tugela Heights including the capture of Cingolo and Monte Chinto and the attack upon Inniskilling Hill, all these are fully and accurately described in the 3rd Volume of the *Times History of the War in South Africa*.

To quote from the latter history, "On March 3rd Buller's army made its formal entry into Ladysmith, and the bronzed and service-begrimed battalions of the relieving force marched proudly through the streets lined by the haggard and emaciated garrison. It was a stirring moment and one full of pathos, as men recognized old friends and comrades-in-arms, or looked vainly down the ranks for those whom they expected, but whom they were destined not to see again. After the parade was over, addresses read by the Mayor, and speeches delivered, Buller issued a special order to the troops of both forces, thanking them for their efforts."

Thus ended the campaign for the relief of Ladysmith. In the memory of the British people it will long live as a deeply dramatic event, with its alternations of hope and disappointment, with its tale of struggle oft renewed to be crowned with success at the last.

That Buller did at last break his way through to Ladysmith, was due to two causes; to the weakness of his adversaries, and above all to the fundamental soundness of the material of which his army was composed. It was the virtues of the British regimental officers and the men whom he led, that in the end broke the Boer resistance and relieved Ladysmith.

Their fearless courage, their patient endurance, their imperturbable cheerfulness in defeat, their unquestioning loyalty to their leader, lend dignity and pathos to a story which would otherwise be depressing, and give a sure hope of better things. If there is one clear lesson to be drawn from the Tugela Campaign, it is that British soldiers, trained as they might be trained, and led with courage and science, need fear to match themselves with no army in the world.

THE END.

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NOTICE OF MAGAZINE.

REVUE MILITAIRE SUISSE.

No. 10.—*October.*

PROGRESS OF RIFLE PRACTICE OUTSIDE THE SERVICE SINCE 1874.

This article deals with the voluntary efforts made in Switzerland to improve the marksmanship of the manhood of the nation. In an editorial note it is stated that the article appeared originally in the *Monatschrift für Offiziere aller Waffen* for June and August, 1914, and that the expression "outside the service" ("*en dehors du service*") has been retained as a part of the original title, because it is the officially recognized one. This expression has acquired a technical meaning in Switzerland but is misleading, since the subject matter of the article really deals generally with the military rifle practice not included in the official firing courses laid down for the Swiss Army.

A review of the situation which existed during the period 1862—1876 is given in an introductory section. In 1874 a reorganization had brushed away the Cantonal Contingents and created the Swiss Federal Army; however, it did not touch the élite and the landwehr but only the infantry. Prior to 1874 all ranks armed with the rifle, whether as infantrymen, élite or landwehr, were required to take part in rifle practice either as members of voluntary clubs or associations, or at meetings specially organized for the purpose, the State providing certain monetary contributions. The Communes were at that time required to provide suitable rifle ranges. Clubs for the encouragement of rifle practice were also recognized in connection with the new state of things introduced by the reorganization scheme of 1874. Official Regulations in connection with practice with military rifles were laid down in Switzerland as far back as 1850. The Regulations of 1863 imposed, *inter alia*, the following conditions on such associations:—

(i.). The membership was fixed at a minimum of 15.
(ii.). Military rifles and ammunitions had to be used.
(iii.). The targets had to conform to the pattern laid down in the official rules and regulations.
(iv.). The articles governing the association had to be framed on lines approved by the Cantonal military authorities.

Statistics are given relating to the associations existing in certain years between 1864 and 1872, their membership and the monetary grants made to them. Matters connected with the voluntary rifle clubs for the period subsequent to 1876 are dealt with under four distinct subheads,

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relating to the years 1876 to 1883, 1883 to 1893, 1893 to 1908 and 1908 to 1913 respectively.

Many attempts have been made in Switzerland to deal with the question of the training of soldiers in rifle practice by utilizing the organization of the rifle clubs, which have existed in Switzerland for many decades now, and several laws have been passed on the subject. The question has also been much discussed at the meetings of the Federal Association for the encouragement of voluntary rifle practice. A considerable impetus was given to the formation of rifle clubs by a law passed by the Federal Council in February, 1893, which caused an enormous increase in the number of these clubs and in their membership, for whereas in 1889—1890 there were only 143 such clubs with a membership of 6,039, in 1906 their number had increased to 1,881 with a membership of 88,661. The introduction of a new military organization, in 1907, led to a still further increase in the number of these clubs to 2,373, and their membership at the same time rose to 109,340. The State contributions to rifle clubs has also increased very considerably; in 1877, the annual State contribution amounted to £5,650 only, but in 1913, this contribution was £28,000, and to this sum should be added another £45,000 in respect of the rebate on the sale price of ammunition, the subsidies paid to dealers in ammunition, and the cost of transport.

The Swiss Flag.

The national flag of Switzerland, as well as the name by which its people are known, are a heritage from the conquerors who first successfully struck the blow against an Austrian foe in defence of the liberties of the Forest States of the early 14th century. If the ancient chronicles are reliable, it would appear that the mountaineers of Schwytz, who fought against Frederick the Handsome of Austria, in November, 1315, on the slopes of Morgarten, had for their standard a red banner with a white cross in the sinister upper corner. It is well known that the mountaineers of Schwytz fought for Rudolph of Hapsburg at the Siege of Besançon in 1289, and ancient records seem to indicate that it was this prince who first accorded to the mountaineers of Schwytz the right to bear, on their banners, the Christian symbol of the Holy Roman Empire which is now the national emblem of Switzerland. In due course the cross of Schwytz became the rallying signal of the upholders of the Confederation. The oldest flag bearing this symbol is thought to be that of the Swiss Auxiliaries of the Teuton Order of Knights captured by Ladislas V., King of Poland, at the Battle of Tannenberg in 1410. This flag was up till quite recently one of the trophies of war hung in the Cathedral of Cracow. In 1480, the Diet of Lucerne decided that each contingent of the Swiss levies, raised by the Confederation for service under Louis XI., should carry its own Cantonal flag, but with a white cross thereon. A similar decision was promulgated at Zurich in 1507, when 6,000 men were raised for service under the Emperor Maximilian.

An illustration is given in the *Revue* of a "banner of honour" presented by Pope Julius II., in 1512, to the Schwytzers; it has a repre-

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sentation of the Virgin and Child in the centre and of the crucifixion in the sinister upper corner. At the meeting of the Diet held at Baden in 1540, a decree was published, providing that the first body of Federal troops sent to the Allies of Rottweil in Suabia were to carry "a red flag with a square white cross."

In the XVII. and XVIII. centuries it became the practice of the Cantons to embroider the "cross of Schwytz" on their Cantonal colours; the same practice having been followed by the colonels of the Swiss regiments raised for service as foreign legions. Illustrations of the Zurich banner borne at Marignan as well as others of historical interest appear in the *Revue*.

At the period of the Revolution, the Helvetic Republic, "one and indivisible," received from the Council, which assembled at Aaran, a tri-colour flag; green, red and yellow. At the same time, the Cantons were obliged to surrender their ancient colours to the new government. The Act of Mediation under which Napoleon was pleased to give the country a new constitution in 1804, not only restored to the Cantons their ancient sovereignty, but also the particular flags formerly appertaining to each of them. It was in 1815 that Switzerland once more adopted the federal colours and emblem which to-day float in profusion throughout the little Mountain Republic.

The design for the Seal of the restored Confederation prepared by Aeberli in 1814, was accepted by the Diet of Zurich on the 4th July, 1815. It consisted of a shield having a white cross on a red ground surrounded by the arms of the XXII. Cantons arranged in historical order of precedence. A Federal Order in Council issued in 1889 defined the Swiss arms as consisting of a white rectangular cross, on a red ground, each arm symmetrical in relation to the centre, but of which the vertical member was to have a length one-sixteenth greater than the horizontal. These arms were popularized during the first years of the Restoration by their adoption in 1817 as a badge for the army. By an article in the Regulations of 1841, the Cantonal battalions of the Swiss Army were given colours consisting of materials of the Cantonal colour, bearing the name of the Canton in letters of gold on the horizontal arm of the Swiss Cross.

The ancient Swiss regarded their Cantonal banners as something very sacred. Large standards of the Cantons were only displayed publicly when events of importance affecting the honour and existence of the State were agitating men's minds and the Militia, in consequence, was mobilized. The standard-bearer was always a magistrate, and the guard, which consisted of considerable numbers, was chosen from amongst those having the reputation for bravery. Each member of the guard had to take an oath "to guard the standard, and if the standard-bearer fell, to pick it up and raise it aloft himself or to deliver it into the hands of another and never to abandon it, either by day or by night, until death." The flag of the conquerors at Morgarten symbolizes, in Switzerland, the national life of its people, the thirst for independence, the ideal of justice and Christian fraternity, the very justification for its existence as an European state. It recalls the liberty enjoyed during the six centuries which have gone by.

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Notes and News.

Switzerland.—Questions affecting the censorship still occupy a prominent place in Switzerland. A correspondent deals with the recent decision of the Committee of Control of the Press, which has unanimously decided not to permit the circulation in Switzerland of a German translation of the official report, known as the Red Book, of the Belgian Commission of Enquiry into Germany's violations of International Law during the present War. It is considered that the Federal Council has acted erroneously in making " lois d'exception " and that the sooner a return is made to the ways provided for under the Constitution the sooner will there be a return to truth. It is held that the Federal Council was badly advised in permitting a military *régime* in Switzerland before there was a real necessity for the adoption of such a measure, and that, in consequence, harm has been done to the *morale* of the army. Confidence in the Federal Council appears to have been further disturbed, so far as the French section of the population is concerned, by its suppression of the recent work entitled " J'accuse" dealing with the German situation ; it is said that the Federal Council has created a new offence, *lèse-neutralité*, which cannot be justified either on juridical, philosophical or any other grounds whatsoever and the Council, therefore, is held to be acting in an unconstitutional and arbitrary manner. What is thought to be a particularly serious matter is the suspicion that the Swiss military chiefs are, by reason of their admiration of the German Army and of an excessive confidence in the final triumph of this army, supposed to be the instigators of the unfortunate policy against which complaint is being made.

Reference is again drawn to the incident connected with the suspension of the *Bibliothèque Universelle* and the opinion is expressed that it was unnecessary for the Government to proceed against this publication under the special powers conferred by the Ordinance of July last since the Swiss Penal Code contained ample provisions to meet the situation ; the only difference is that under the latter the case against accused must have been tried before a judge *and jury*. Had this been done the latter would probably have returned a verdict of acquittal and there would then have been nothing more to say. It is suggested that the Federal Council may yet regret having assumed a dictatorship, however laudable may have been its intentions. Copies of photographs, from the German translation of the Belgian Red Book, are published with this number of the *Revue*. They show the interior of a damaged church in Termonde, a part of the damage to the town, the ruins of Dinant and wounds inflicted by explosive cartridges.

This number of the *Revue* concludes with a bibliography.

Supplement.

The European War.

The study of the great European War, which was begun in the *Supplement* issued with the number of the *Revue* for February last, is continued in the *Supplement* issued with the number of the *Revue* for October, 1915 (*vide R.E. Journals* for June and September, 1915, and January, 1916).

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The Contest for Hill 60.

The story of the contest for Hill 60 was commenced in the *Supplement* issued with the number of the *Revue* for September last and is completed in the number under review.

The height known as Hill 60 is situated to the S.E. of Ypres and to the S.W. of Zillebecke. Although of relatively small altitude, this height effectively commands the plain which lies adjacent to it. The British troops captured this height in an attack made during 17th—19th April, 1915. The success obtained at this point was referred to in a British official report dated 20th April last. The report in question states that the operations were commenced by the explosion of a mine, which resulted in the killing of several German soldiers and the capture of 15 others, including an officer. The German counter-attack of the 18th April is referred to in this report, and it is stated therein that the German troops advanced, in close formation, under the fire of British machine-guns and were repulsed all along the line with heavy loss.

The German headquarters kept the German public informed of the incidents of this contest in communiqués issued on the 18th and 19th April. In a German communiqué, bearing the first of these dates, it is admitted that, after the explosion of a mine on the previous day, the British obtained a lodgment in the German position S.E. of Ypres, but it is claimed that these British troops were driven out again by a counter-attack; the German communiqué finishes up by saying:—"The contest is now alone in progress for the possession of the three craters." In the German communiqué of the 19th April the announcement appears:—"To the S.E. of Ypres, the British have been hunted out of the small portions of our position which they were still holding. Last evening they attempted to retake the hill, by a violent attack directed along the Ypres-Comines Railway. This attack failed with heavy loss." The contradiction in the accounts of the two sides is absolutely complete. In the British Isles, the impression was that the British troops were in possession of Hill 60, in Germany a contrary view prevailed. The news published on the days following ought, without doubt, to have cleared up the situation. It might be taken for granted that if the Germans had lost a position of some importance, something would be said of the efforts to retake it. The silence of the German headquarters on this subject, after the 19th April, and the report emanating from London on the day following provides ample evidence respecting the true facts of the situation. The victory of the morrow had wiped out the defeat of the yesterday.

The tactical experiences of the War also afford some guarantee, even in the absence of fresh information from Berlin, that the reports of the Allies would tell of the Germans returning to the charge. For from the very nature of the operations connected with the attack and defence of fortified positions on the Western Front, such reflex movements had taken place almost from the very beginning of the trench warfare; experience had shown that three phases generally occur in operations of this kind.

The first is that connected with the reconnaissance of the position to be captured, coinciding with the operation of driving back the advance lines of the enemy covering the approaches.

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The second is that of the decisive attack which, if it should succeed, provokes an immediate countermove of the side dispossessed of its defences for the purpose of driving out the intruder before he has had time to make good his hold on the position seized. If the counter-attack succeeds, the original attacker has to recommence his operations.

If the first countermove fails, the third phase opens. The side dispossessed still continues to cherish designs on his lost trenches. But in the meanwhile the new possessor makes himself at home in the position captured, and proceeds to prepare plans for a further forward move.

If the similarity of the two accounts to numerous precedents to which they can be compared is not deceptive, it may be safely conjectured that the Germans probably obtained some success in their first counter-attacks, as claimed in the German communiqués of the 18th and 19th April; but it is equally probable that they hid up their final want of success. That is to say in their accounts they omit reference to the intermediate operations and pass straight away to the last phase. In that they claimed to be still in their original positions, they as good as burnt their boats behind them; for this reason they could no longer say that they had regained this position without, at the same time, admitting that they had lost it. The British account bears the impress of truth; from the moment that Hill 60 was occupied there was no sound reason to invent news concerning fresh fighting in this region. If such fighting did take place, as the Germans state, it could logically only have been connected with the third phase, that is to say with an attempt on the part of the Germans to regain the ground lost.

Further enlightenment on the situation was first obtained from a French communiqué issued at 7 a.m. on the 22nd April; this announced that a German counter-attack against Hill 60 had been repulsed by the British troops. At the same time it was stated that the German losses at this point had since the 16th April amounted to some 3,000 to 4,000 men. A second French communiqué dated 7 a.m. 23rd April announced that the British troops had repulsed two German attacks against Hill 60 and that the German losses had been more serious than previously announced.

The British General Headquarters reported, on the 22nd April, that the Germans were continuing their counter-attacks against Hill 60, and that many German attacks had been repulsed. On the day following, a further report (from British General Headquarters) made mention that the German counter-attacks on Hill 60, to the west of Zwartelen had been several times renewed since the issue of the last report and that *all these attacks had failed and that they had ceased for the time being.* At the same time, it was definitely stated that the British troops were holding the summit of Hill 60, and that there was not a word of truth in the German official communiqué in which the claim was set up that the Germans had recaptured the position.

A fortnight later, namely on the 5th May, the Germans made a gas attack on Hill 60 and recaptured their lost trenches; however, Berlin was naturally unable to announce this fact, but it was made known by the British Commander-in-Chief. The British explanation was far from

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satisfying the German Headquarters which issued its own account of the affair on the 7th May, in the following terms :—" Near Ypres, all attempts of the British to recapture Hill 60 which has been, since the 17th April, the centre of the contest and is situated to the S.E. of Zillebecke, have failed."

This was by way of confirming the German communiqués of the 18th and 19th April, referred to earlier, in which, contrary to the truth, the capture of Hill 60 by the British troops was denied. The issue of the last attack on the hill was represented by the Germans as if the *rôles* played by the two sides had been reversed ; instead of announcing that it was the Germans who had attacked and expelled the British troops, it was made to appear that it was the latter who had attacked and had failed to expel the former.

Later the German Headquarters gave itself away badly, when speaking of the recapture of this position by means of a gas attack. This example of German Press methods is one of the most interesting. The cycle of permanent victory for the Germans was complete. Here was a denial of an enemy success put right by the account given of an event of a much later date, the careful editing of the announcement relating to which completely altered the complexion of the true facts of the real situation. The attack, which made good a previous defeat, thus became the final episode of a victory falsely claimed at an earlier date.

The situation was very similar to that connected with the Battle of the Marne. Information concerning the German repulse at Hill 60, between the 17th April and 6th May, was no more allowed to become public property in the Fatherland than was the German retreat from the Marne.

The Second Battle of Ypres.

The Surprise caused by the Use of Asphyxiating Gases.—On the 23rd April last, the German Headquarters announced that, on the previous evening, the German troops had directed an attack from their front Steenstraat to east of Langhemarck against the Allied positions to the N. and N.E. of Ypres, and that these troops had pushed forward with *élan* on a front of over 5 miles up to the high ground south of Pilkelm and to the east of this locality. It was further claimed that during the course of a desperately contested struggle, the German troops had seized the crossing over the Ypres Canal near Steenstraat and Het Sas and had established themselves on the west bank of the waterway referred to. It was stated that Langhemarck, Steenstraat, Het Sas and Pilkelm had been captured and also 1,600 British and French prisoners, 30 field pieces and 4 heavy British guns.

On this same 23rd April and on the day following, the French General Staff substantially confirmed the news from Berlin, adding an explanatory note. From this note the public learnt that on this occasion the Germans had, for the first time in the War, used bombs giving off asphyxiating gases, which produced injurious effects at a distance of over 2,000 yards in rear of the Allies' trenches. It was learnt from German soldiers taken prisoners about this time, that asphyxiating gases were in future likely to be regularly employed by their commanders in

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connection with their further operations; and also that the German soldiers had been provided with protective appliances for use in the event of the Allies employing asphyxiating gases as a retaliatory measure.

The British General Staff also furnished explanations in relation to the matter; the gas attack, it would appear, was first made against the British left, at that time located near Bixschoote and Langhemarck to the north of the Ypres salient, and was begun by the release of poisonous gas from a great number of reservoirs or generators. The Germans must have had their preparations for the use of asphyxiating gases in hand for some considerable time beforehand, and did not overlook the precaution of having some excuse ready in advance to justify the contemplated breach of the provisions of The Hague Convention on this matter. For more than a fortnight before—the first mention was made on the 9th April—the German communiqués had been accusing the British, the French and the Russians alike of using stupefying or asphyxiating gases. As soon as the surprise of the 22nd April was sprung on the Allies it soon became evident that the Germans had, in anticipation, utilized the *manœuvre morale* to make it appear to neutrals that, in employing this new weapon of war, they had been provoked, by their enemy's breach of the recognized code, to adopt retaliatory measures.

Berlin, it would appear, recognized that something more substantial than mere affirmations, without any evidence whatsoever, was really necessary to justify the breach of the provisions of The Hague Convention, and the German Legation at Berne—and probably the German diplomatic representatives in other neutral capitals—furnished the Swiss newspapers with an explanatory memorandum; it is dated Berne, 12th July, 1915, and in it is put forward the allegation that the French and British troops resorted to the use of asphyxiating gases long before the German Army did so. In support of this allegation the Swiss papers were supplied by the German Legation with copies of a document issued by the French Ministry of War, on the 21st February, 1915, describing gas-grenades and canisters. The German explanatory memorandum and the French description of the gas-grenades and canisters are reproduced in the *Supplement*; in the concluding paragraph of the explanatory memorandum it is stated :—" This French communiqué no longer leaves any doubt on the point. It proves that the French were the first party to use asphyxiating gases. The reproaches addressed by them to the German Army are therefore particularly misplaced."

It was very natural that the French authorities should publish a reply to the above allegation. This was done without delay, and on the 16th July, 1915, the Havas Agency issued a note to the Swiss papers, in which attention was drawn to the difference between the gases employed by the Germans in their trench warfare and that produced by the gas-grenades and canisters described in the French document of the 21st February, 1915. The Havas note states that, whereas the gases employed by the Germans seriously affected the organs of the human being and in many cases caused the death of the victim gassed, after painful sufferings, on the other hand, the gases given off by the French grenades and canisters referred to were not deleterious, but only produced a state of intense stupor for a time, which wore off leaving

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the organs of the victim uninjured. In a word the difference in the effects produced by the French and the German gases was as wide as that produced by the use of stinking water as compared with that produced by the use of vitriol. It is not proposed to discuss here the question whether the use of deleterious gases is either legitimate or within the code of the ethics of war. It is sufficient to take cognisance of the fact that German officialdom practically admitted the illegal action (from the point of view of International Law) of the German military authorities in this matter, since it went to the length of attempting to put the onus for the initiation of gas attacks on to the shoulders of their adversary. This truly constitutes the *manœuvre morale* designed with great care and launched in anticipation of the great move it was intended to cover.

The Germans showed great cleverness in the way they introduced, by gradual stages, the subject of the alleged use of poisonous gases by the Allies. Nevertheless, the German accounts in relation to the methods of employment of poisonous gases alleged to have been used by the French do not tally with the methods for the use of stupefying gases described in the document of the French Ministry of War, dated 21st February, 1915, contributed by the German Legation to the Swiss papers, whilst these German accounts do describe very clearly the procedure adopted by the German troops in carrying out their own gas attacks. So far as neutral countries were concerned, it was futile on the part of the German Legation to seek, in their explanatory memorandum of the 12th July last, to create confusion in the public mind between a gas which irritates the nostrils, and one which destroys the pulmonary organs. The *manœuvre morale* resorted to in this case was only another example of the persistent use of equivocation. In this new field, there is seen once more the adoption of a course which was similar to that to which attention has already been drawn in relation to the attack on Liège, the equivocation between the terms *town* and *forts*; similar to that in relation to the operations in Northern France, the equivocation between the fighting on the Meuse and the new battle claimed to have been fought at Rheims; similar to the situation which existed on the Marne and the Aisne, the equivocation between a compulsory retreat and the adoption of a defensive-offensive attitude.

Even in relation to subsidiary details, the German methods did not alter; of this the employment of asphyxiating gases provides additional testimony. For instance, at the end of July last, the German Headquarters contributed a second memorandum to the newspapers. Under the title *Un aveu du commandement français*, there was reproduced what was alleged to be an order of the 112th French Regiment of the Line wherein there appeared statements, *inter alia*, to the effect that asphyxiating gas shells used by the Germans, in an attack made on the 20th July last, in Alsace, contained a substance capable of giving off a very strong smell, of causing tears to flow and of exciting violent coughing, but possessing no poisonous properties. According to the information contained in the order referred to above, the inhalation of the gases produced from the German shells was distinctly unpleasant, but dangerous only in a very small degree. The German memorandum went

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on to say that the French, after having been the first to use projectiles giving off poisonous gases, had dared to accuse the Germans of being guilty of a similar act, they (*i.e.* the French) knew—witness the order of the 112th French Regiment of the Line—that their accusations were false; further, the French were also fully aware that the German gases were not capable of producing fatal effects; these gases were not even dangerous, but only unpleasant to inhale.

The terms in which the German justification is drawn up has a flaw, and this, one of vital importance. It may well be that the gases employed by the Germans *in Alsace on the 20th July* were not capable of producing fatal effects, but this is by no means conclusive evidence that the gases employed *in Flanders in April last* were exactly similar. Indeed, it would not be a matter for surprise if, as a matter of fact, between April and July, 1915, the indignation aroused against German methods, and the stain caused thereby on the reputation of the responsible chiefs had proved to be such as to result in a demand for a change of policy being made on the chemists in the German Munitions Service to prescribe new gases for the purposes of German warfare.

The Tactical Surprise at the Beginning of the Battle.—The Anglo-French troops holding the Ypres salient, consisted of a French Division on the line Steenstraat-Langhemarck-Poelkappelle facing north; a Canadian Division on the line Poelkappelle-Becelaere facing N.E.; a British Division on a curved line from Becelaere by the east of Zonnebeke to a point west of Becelaere, facing southwards; parts of the 5th British Army Corps extended from the point last mentioned towards Hill 60 and St. Eloi facing east. Four battalions of the 5th British Army Corps and one battalion of the Canadian Division were held as a Divisional Reserve at Ypres; a Canadian Brigade, at the same place, constituted a second-line reserve; lastly a British Infantry Brigade which had sustained heavy casualties in the contest for Hill 60 were at Vlamertinghe. The Belgian Army was stationed on the line Steenstraat-Dixmude and beyond, in extension of the French left flank.

The Real Version.—The action began at 5 p.m. on the 22nd April last. After a vigorous bombardment of the whole length of the Allied position, the Germans delivered an attack against the sector held by the French and for the first time in history a tactical success on the field of battle was obtained by the discharge of poisonous gases. An extract from the British Commander-in-Chief's report dealing with the incident is reproduced in the *Supplement*; in it he points out that the effect produced by the poisoned atmosphere was so staggering that all action became impossible along the whole length of the front held by the French Division. The fumes of the gas were so dense that it was impossible to see through them. Hundreds of men became comatose and in less than an hour the whole length of the position gassed was abandoned, about 50 guns being lost in this way. No blame whatever attached to the troops in connection with the loss of this section of the position; no troops in the world could have held on to the trenches under similar circumstances, for the use of poisonous gases being at that time quite unexpected, no protective helmets or other appliances had been provided for the troops.

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The gases having cleared the Allied troops out of the way the German offensive succeeded in reaching, on its right, the Yser Canal; in consequence, the bridge at Steenstraat and some works on the west bank of the canal south of Lizerne falling into the hands of German troops. Opposite the German centre, between Bixschoote and Langhemarck, the French were pushed back to the north and to the south of the Staden-Ypres Railway, as far as the bridge over the canal. This retirement brought in its train a double danger; on the west wing, the possibility that the Germans might drive a wedge between the French Division and the Belgian Army; on the east wing, the possibility that the flank of the Canadian Division might be uncovered; if this happened it would result in involving the last-named division in the retirement which had taken place. This double danger was increased by the reduction in the number of French guns and the loss of a heavy British battery which had to be abandoned in the confusion. The Reserve was pushed forward to the rescue of the Canadian Division which had held on most obstinately to their position. The Allies launched counter-attacks against the Germans, the French troops delivered a charge, and finally, at 10 a.m. on the 23rd April, contact was re-established between the French and Canadian Divisions and a new Allied front was formed, some 700 yards to the east of the canal. The unknown nature of the situation as regards the Belgian Army was met by placing a part of the Reserve under the immediate orders of the Commander of the French Division. The situation still remained critical; the Germans taking advantage of their superiority in guns, continued to display exceedingly great activity along their whole front. The German activity increased still further during the 23rd April, owing to the arrival of heavy guns from Ostend. Fresh troops of the 5th British Army Corps now came into action and the vigorous counter-attacks delivered by them resulted in the Allied front being held.

A consultation had taken place on the morning of the 23rd April between the British Commander-in-Chief and General Foch the commander of a group of French armies in the north. The latter proposed to advance to the attack with the object of regaining the original front held by the Allies at the time of the gas attack. These reinforcements would require some days to reach the fighting line; in the meantime, it was essential that the Canadians should hold on to their position. It was agreed that, if delay occurred in bringing up General Foch's troops, other dispositions would be made as it was not possible to allow the British troops to remain in the exposed situation they occupied, for long. Meanwhile orders were issued to two brigades of the 3rd British Army Corps and the Lahore Division to reinforce the Ypres front.

The Germans realized that their opponents were in a critical situation, among other things, in view of the latter's inferiority in artillery, and they therefore, no doubt, hoped that the new methods of warfare introduced by them would continue to give them further advantages of the kind they had already succeeded in obtaining. On the morning of the 24th April, indeed, the Germans gained two further successes. An attack delivered by them in the early hours of the morning, at the point of junction of the French and Belgian troops on the west bank

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of the canal, placed the village of Lizerne in their possession, and they also succeeded in piercing the Allied line near Saint-Julien where the French and Canadian Divisions joined up, and the village last named also passed into their possession. For two days fierce fighting took place. A counter-attack delivered on the 24th April by the British troops with the object of recapturing Saint-Julien failed in its purpose but checked the enemy's further advance. The Germans delivered no less than six counter-attacks against the Canadians who, however, held their position and maintained contact with the French on their left.

On the 26th April, the Lahore Division and a British Cavalry Division was pushed into the fight, at the point of junction of the French and Canadians. The Germans were repulsed and driven back a short distance towards the north, but continuous discharges of poisonous gases interfered with the progress of the Allies. A battalion of the Northumberlands succeeded in reaching and occupying the southern parts of Saint-Julien, but were eventually driven out by a gas attack. The German success at Lizerne was temporary only, for French and Belgian troops later recaptured this village.

The French Version.—The French communiqué dated 3 p.m., 23rd April, makes mention of the withdrawal of the Allied troops from their trenches and of the retirement of the left wing towards the west and of the right wing towards the south. However, no mention is made of the furthermost points reached by the Allied troops in this retrograde movement, nor of the capture by the Germans of the canal bridge at Steenstraat. The announcement contained in the French communiqué that the enemy had been checked and that the lost ground had been recovered by a counter-attack immediately produced a sense of relief in the public mind.

The (French) communiqué issued at 7 a.m. on the 24th April is reproduced in the *Supplement*. It announces that the Anglo-French troops had regained the lost ground towards the north, situated between Steenstraat and the Ypres-Poelkapelle Road.

A second French telegram, issued on the 24th April, provides the supplementary information that the gas attack had been renewed. Information concerning the counter-attack of the 23rd April is repeated and encouraging news is given with regard to the general situation. Thus is made patent, first, the care exercised by the authorities not to permit the public to exaggerate the dangers likely to result from the innovation introduced into the methods of warfare employed by the Germans, which had proved so efficacious at its initial stage and to combat which the Allies had adopted no anticipatory measures; secondly, the intentions and hopes of the Allied chiefs, the execution of whose plans were resulting in the recapture of the ground lost and the re-establishment of the former front. The public mind having been quieted, the intentions translated into action and the repairing of the damage done begun, the subsequent telegram told the extent to which the mischief wrought had been further made good. It is a repetition merely of a procedure now well known. This part of the examination concludes with the French communiqués of the 25th—27th April, which tell of the German gas attacks and of the continued progress made by the Allies in regaining the lost ground.

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The British Version.—During these three days, the tone of the British telegrams conformed to that adopted in connection with the Battle of Neuve Chapelle; they were spare in the use of words, gave a brief outline of the main lines of attack and defence and made mention of the principal features connected with the progress of events, even those which were unfavourable to themselves, in two or three well-chosen words.

The telegram of the 23rd April describes the effect produced on the French Division by the gas surprise and adds that the French were obliged to retire during the night to points outside the gas zone; they retired towards the canal. The telegrams of the 24th to 26th April deal with the incidents already described earlier in this review under the subhead *The Real Version.* In the concluding portion of the telegram of the 27th *idem* it is stated that desperate fighting continued to the N.E. of Ypres. The general situation had not changed; the Germans had seized Saint-Julien. The British public had been apprised of the full facts and were aware that owing to the dastardly methods introduced by the Germans, the French, taken by surprise, had been obliged to retire, thus uncovering the British left and that the British had, in consequence, also to retire in order to maintain the continuity of the Allied front. The public also learnt that the Germans had captured Saint-Julien, though no mention had been made, at this time, of the fact that the loss of the village was due to the employment of gas by the Germans; it was only when the full despatches were published that reference was made to the use of poisonous gases by the Germans.

The German Version.—The German communiqué of the 23rd April mentions the decisive character of the German attack directed against the Allied position north of Ypres; the capture by the Germans of Steenstraat, Het Sas, Pilkem; the crossing of the Yser near Steenstraat and Het Sas by the German troops; the numbers of British and French troops taken prisoners and also of the field and heavy guns which fell into German hands. This was only a beginning; further information was reserved for later telegrams; that of the day following (the 24th April) announces that all attempts on the part of the enemy to dispute the possession of the ground captured to the north and east of Ypres had failed, and went on to say that the number of French, British and Belgian prisoners had risen to 2,470 men, the number of captured guns to 35, and that in addition many machine guns and rifles and large quantities of stores also fell into German hands. German communiqués, written in the same tone, continued to be issued for some days subsequent to the date last mentioned. Those for the 25th to 27th April are reproduced in the *Supplement.* Reading these series of telegrams, the German public could not have formed any other view on the situation than that a victory had been gained, a victory moreover which was definite and final resulting as it did in the capture of Ypres, the piercing of the Allied position, maybe in the conquest of the last square yard of Flanders, and even in the resumption of the great march towards Paris and Calais. There could be no doubt in the minds of the German public that Lizerne had been captured and destroyed. What loomed largest

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was the capture of the canal crossing and its retention in German hands; it was not likely, so the public would imagine, that German troops would hold on to this crossing unless there was some strong military reason for so doing. This success was the beginning of the operation of which the bombardment of Poperinghe was the next step, to which reference is made in the German communiqué of the 27th April. It would lead the Germans on to the lines of communication of the enemy, that is to say, to the rear of the Ypres Salient. The successful attack of the 23rd April had already reached this stage on the 26th *idem;* the final triumph could not be far distant.

Conclusion.—The comparison of the three versions is an exceedingly interesting study. The French version is diplomatic; the account of the fight is tinted to suit the several incidents thereof; it contains admissions of enemy successes; discretion was exercised in regard to the hour of issue. The public became aware that the French arms had met with a reverse, but a reverse which was in no way discreditable. There was hope that the mischief would soon be compensated for; it was sufficient to await the morrow with confidence, in spite of the uncertainties of the situation.

The British version relates facts, and these alone. The Allies had met with a reverse, a reverse which had taken a heavy toll in men and *matériel*, and the damage done still required to be rectified. The public were, however, required to put their trust in the tenacity of purpose of the troops; these would only give way further when the situation made the adoption of any other course impossible. It was too soon then to express regrets or give way to despair.

The German version has a cocksure tone about it, and finishes up with an equivocation. For the bombardment of Poperinghe was only dust to throw in the eyes of the civil population; a bombardment carried out at very long range against a locality considerably behind the position, against which the Germans had found themselves not only held up by obstinate defenders, but in front of which they had been obliged to give way just at the time the tactical needs of the situation demanded a further advance on their part in order to give significance to the bombardment referred to. This was only another exemplification of the *manœuvre morale* destined to stimulate the public just at the time the *manœuvre militaire* appeared to be on the point of losing its efficacy.

These three versions do not exactly represent the intentions and aspirations of the Army Chiefs. The French Army Group Commander had decided to regain the lost position. The German Commander had scored a success by the employment of novel means of warfare; he felt that he had a superiority in guns; he had no doubt whatever that further successes were in store for his troops. The British Commander-in-Chief was ready to support his French comrade-in-arms, but on condition that the delay in bringing up reinforcements did not further compromise the hazardous position in which his troops found themselves; otherwise, he would be compelled to take steps to minimize the risks run by his men.

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The British Retreat.

First Phase.—On the 4th May, the British Commander-in-Chief addressed a communication to his Government, in which he pointed out that the loss of ground, resulting from the German gas attack, had made it necessary to alter the line held by the British troops on the Ypres front and that the new line taken up ran westward towards Zonnebeke. During the week previous to the date last mentioned very little information had been given out from the British General Headquarters. On the 28th April, it was announced that the joint operations of French and British troops had checked the Germans and that, on this date, the last named had not renewed their attacks. Up to the 1st May, no further change had taken place on the British front. The French communiqués of this period were not enlightening; they referred to the fighting at Steenstraat, in which French and Belgian troops were engaged. The British telegram of the 3rd May gives the principal information; it mentions the German gas attacks, one to the north of Ypres near Saint-Julien, the other to the east, at Hill 60. Neither of these attacks was successful. The key to the mystery must be sought for in the German version; this version is very categorical, according to the practice adopted since the beginning of the War. It states simply that the British troops had been defeated and had yielded ground before the victorious advance of the Germans.

The German communiqués of the 28th April and those of 2nd to 5th May are reproduced in the *Supplement*. The one first mentioned speaks of two British attacks, at Pilkem, near Ypres, which are said to have failed with heavy loss and it is definitely stated in this communiqué that the enemy had made no attack on the west bank of the canal. The German communiqués of the 30th April and 1st May made no mention of the British troops. The communiqués of 2nd to 5th May announce victories won by the Germans against British and French troops at the point of the bayonet in the region N.E. of Ypres. In the absence of a detailed reference to this fighting in the British version, it would have been difficult to contradict the Berlin account, but it so happens that a Paris telegram of the 3rd May makes mention of a German attack against the British front north of Ypres, which was repulsed by the Allied troops. This last reference may allude to a mere incident of the fight, as on the day following the British General Headquarters admitted the retirement of the British troops.

Since then the British Commander-in-Chief's despatches relating to these operations have been published and convey a very different impression regarding the events to which they relate than is to be gathered from the German communiqués. The account given in these despatches of the operations is in agreement in every particular with the fragmentary communiqués issued by the General Staffs of the Allies between the 23rd April and 5th May; the account given in the despatches is merely the original framework with the details amplified. That this version describes the actual situation is evidenced by the intention to retire, clearly expressed by the British Commander-in-Chief, on the 23rd April, *i.e.*, the day following the surprise caused by

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the gas attack, at the interview with the French Army Group Commander, and repeated on the 29th April at a second interview. On each occasion, the British Commander-in-Chief consented to postpone the retirement of his troops, but on condition that the French Division should reoccupy its original position (*i.e.* that prior to the gas attack). This condition not having been fulfilled and the prospect of doing so sufficiently early being remote, Field Marshal Sir J. French decided to put into execution, on the 1st May, the measures agreed upon in principle eight days earlier. It is not a matter of much moment whether these measures were adopted as part of a prearranged plan, as would appear from the British version, or whether they were suddenly necessitated owing to the success of the enemy's attack, as stated in the German version. All indications point in the direction of the British version representing the actual situation more exactly than does the German version. Another presumption in favour of this view lies in the fact that the British report refers openly to the retreat taking place by reason of the renewal of the German attacks.

The Second Phase.—From the time that the British line near Ypres was pierced, on the 22nd April last, the troops holding this front were, as reported by the British Commander-in-Chief, subjected to a continuous German bombardment by a considerable number of guns, the expenditure of ammunition by the Germans being practically limitless. It soon became evident that, under artillery fire of such intensity, it would be quite impossible to dig trenches giving sufficient cover or to re-form the front in the midst of the confusion and demoralization caused by the gas attacks which were now being daily renewed. It was only on the 8th May that protective masks against gassing were first brought into use. The British Commander-in-Chief's despatches draw attention to the fact that on the date last mentioned the German bombardment was particularly violent, first along the whole front, later by the gradual concentration of fire on the salient at that time held by the troops under Sir Herbert Plumer. The German artillery completely destroyed the British trenches and caused exceedingly heavy casualties. Then, a vigorous infantry attack was delivered by the Germans which caused the British troops to break away. Sir Herbert Plumer's own report of the incidents in this part of the field is quoted in the British Commander-in-Chief's despatches and in General Plumer's report the retreat of the British troops is referred to in explicit terms. It was only on the 26th May that the British succeeded in reinforcing their front. In the meanwhile the French had regained the ground lost by them, and on the date last mentioned the British succeeded in effecting a junction with the French front at the same point where the British and French troops had joined up prior to the gas attack.

On the 9th May, a Berlin telegram announced that the enemy had been driven out of their strongly fortified positions between the Fontaine-Wieltje and Gheluveld-Ypres Roads; that Frezenberg and Verlorenhaek had been occupied and thus the Germans had entered into possession of a series of heights commanding the country lying to the east of Ypres. The German report was somewhat exaggerated; the British troops had retired before the German advance precisely because their position had

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not been strongly fortified; they had not been able to dig themselves in owing to the intensity of the fire of the German artillery. On the other hand, the British reports glossed over certain points. The fighting, according to the British reports, had produced no notable change, and in the report of the 11th May, it was stated that in spite of the repeated German attacks during the previous week, the front held by the British troops had remained practically on the same line as that occupied immediately after the retreat of the 3rd and 4th May.

The situation is correctly described and, in spite of omissions, the British report probably gave the public a truer idea of the real situation than the German Headquarters gave to their own people, who were led to expect great things at Ypres in the immediate future. Fortunately, when the operations in Flanders came to a standstill, the important results attained by the great battle in Galicia gave justification for higher hopes being entertained by the British public in relation to the great issues at stake.

The Franco-Belgian Counter-Attack.

Examination is next made of the manner in which the people in the belligerent and neutral countries were allowed to learn of the partial recovery of the lost ground and of the manner in which the Allies succeeded in re-establishing a junction north of Ypres. It is necessary to refer to the account of the operations on the front of the French Division and on the right of the Belgians for enlightenment on this point.

It may be remembered that, on the 28th April, the main German attack on the canal was considered by the Allies to have been checked. The French troops had retaken Lizerne. They had, in conjunction with the Belgians, on the date last mentioned and those subsequent thereto, made progress on the right bank of the canal.

The British communiqué of the 28th April had announced that the German attacks had not been renewed; moreover, there were no Germans west of the canal, except at Steenstraat—at this place they had established a small bridgehead.

The Berlin communiqués were not so modest in the claims advanced on behalf of the German troops. In a telegram dated 29th April, it was stated that the German positions west of the canal, north of Ypres, near Steenstraat and Het Sas had been attacked, since midday of the day before, without ceasing or success. Encouragement is given by recalling the glories of the fight, and the telegram continues: "The number of the enemy's guns captured by us in the fights north of Ypres has risen to 63."

The bridgehead at Steenstraat was represented in the German report as something more important than the value assigned to it in the British report. In the telegram of the 30th April, it was made to appear that the Germans were about to make a further offensive counterstroke; it ran as follows:—"During the night the enemy attacked between Steenstraat and Het Sas. The fight still continues. The bridgeheads on the west bank of the canal, near Steenstraat and Het Sas have been improved by us and we have firmly established our footing in them."

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The Bombardment of Dunkirk.

These telegrams throw light on another incident which could not fail deeply to impress the German mind: Dunkirk had been bombarded.

In France, the public looked skywards and hydroplanes went out seawards to reconnoitre the upper regions of the air. Shells had fallen on Dunkirk, this was an undeniable fact. They commenced to fall at 11.30 a.m. on the 29th May last. Twenty shells in all were fired, which made craters 10 to 15 yards in diameter. At first there was doubt as to whether these projectiles had been dropped by aircraft or fired from warships. As soon as it was discovered that they were shell and not bombs it was recognized that they had not been dropped by aircraft. Since they had a diameter of nearly 15 in. it was also clear that they could not have been fired, owing to their size, by the small German ships known to have been at Ostend. The gun or guns from which these huge shells were fired were soon located behind the German lines, near Nieuport, some 19 miles from Dunkirk. The ballistic properties of this heavy German artillery might well have been a cause of legitimate satisfaction to the German ordnance manufacturers, but the strategic results obtained by this bombardment of Dunkirk were *nil* and could not be otherwise. This shelling of Dunkirk was after all nothing more than an *opération morale.* This artillery display on the part of the Germans was most puerile, since their adversaries had not been driven from their positions on the Yser, no military advantage could be gained by a bombardment of Dunkirk. It would have been thought that rather than waste ammunition on the shelling of Dunkirk, with very long-range artillery, the Germans would have striven to bring a heavier shell fire to bear with shorter-range guns on the troops on their immediate front, where their troops were being held up; this would have proved of immensely greater assistance to their infantry, then engaged in trying to force its way through the trenches held by the Allied troops.

Some explanation of this kind might have been addressed to the civil population of Germany by the military authorities had it, under other circumstances, urged the employment of the long-range artillery for the purpose of the operations against Dunkirk actually carried out, or some other similar operation. However, it was the desire of the German authorities to create the very contrary impression on the public mind; telegrams had described the German offensive stroke along the line of the Yser; early successes had been announced, with reference to the later reverses suppressed; the situation appeared, so far as the German public was concerned, to be progressing very favourably.

It is not difficult to imagine the effect likely to be produced, under these conditions, on a public whose expectations had already been suitably manured and cultivated, by such an announcement as: "The fortress of Dunkirk brought under the fire of our guns," followed next day by the news: "The French stronghold of Dunkirk continues to be shelled by us." The public could well be excused for assuming that such announcements could but mean that the German offensive was continuing to meet with further success. The equivocal nature of these

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announcements became a positive advantage so far as the effect on the *morale* of the public was concerned.

The German General Staff were, at all times, thinking of the morrow, and they continued to hope that it would soon bring with it good luck for the Germans. Should the results aimed at by the Great General Staff, by any mischance, not be fully attained, within given time limits, they could, as has been seen, resort to equivocation in the announcement relating thereto. The bombardment of Dunkirk was intended to connect up two phases in the operations, one that was past and the other that had yet to be put into execution. If the German plans miscarried, there would be no necessity for any telegraphic reports in relation thereto; instead, attention could be directed to some side issue, such as Turkish successes in the Gallipoli Peninsula, the German offensive in Courland, or the preparations for an offensive in the Carpathians.

In all this was to be seen a procedure which was an imitation of that which had gone before. For six months past the changes therein had been no greater than the alterations in the defensive positions occupied by the two sides. The bombardment of Dunkirk was but the ringing of a change on the practice of the past.

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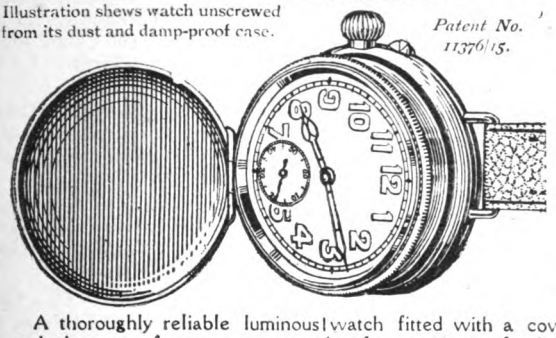

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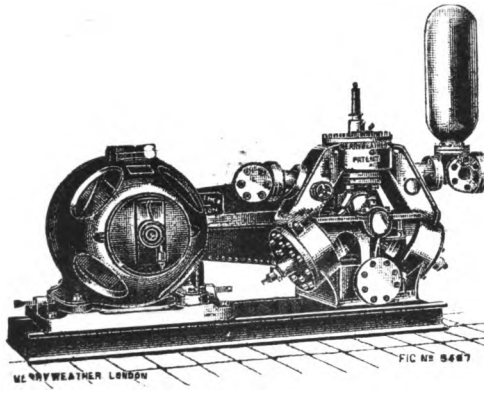

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TELEPHONES.

By SIR WILLIAM SLINGO.

BY the kind permission of the Council of the Institution of Post Office Electrical Engineers we are enabled to reproduce the following address on "Telephones" by the President of the Institution, Sir William Slingo :—

One of the most remarkable features in the history of modern electrical engineering is the extraordinary development of the telephone service throughout the world. In Great Britain the telephone service dates from 1879, when the first Exchange was established in London by the Edison Telephone Company. Other companies licensed by the Postmaster-General commenced operations in 1880, but several of the earliest exchanges in the provinces were established by the Post Office in 1881 and 1882.

The development of the local exchange systems subsequent to 1882 and up to 1900 was due to the enterprise of the companies which were ultimately absorbed by, and consolidated in, the National Telephone Company. The amalgamation of the various companies which was completed in 1890 represented a capitalization of over three millions sterling.

The telephone companies had operated each in its own territory, and there was practically nothing in the way of competition between them. They had erected a number of inter-city lines, but there was no long-distance service as we now know it until the Post Office commenced the construction of the backbone trunk lines in 1892. Most of these lines were completed and working in 1895. In 1896 the Post Office acquired by purchase the trunk lines owned by the National Telephone Company, and the nucleus of a comprehensive long-distance service covering the whole country was formed.

The efficiency of the backbone lines was of the highest grade. Copper conductors weighing 1,600 lbs. per loop mile were used for the longest and most important circuits; for example, the London-Glasgow, London-Leeds, Leeds-Glasgow, Leeds-Carlisle and Belfast-Dublin. Conductors weighing 1,200 lbs. per loop mile were used for the secondary circuits such as Cardiff-Birmingham-Newcastle, and Liverpool-Glasgow; while, for the shorter lines such as London-Ipswich and London-Brighton, conductors of 800 lbs. per mile of loop were erected. These backbone trunks were provided as nominal aerial lines throughout; *i.e.*, the amount of underground was kept as small as was considered possible.

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Mention should be made of the London-Paris telephone service which was inaugurated in 1891. There were two circuits consisting of aerial lines of 1,600 lbs. per loop mile on the English side, and 1,200 lbs. per loop mile on the French side. The submarine section was a 4-core cable, each core consisting of 300 lbs. gutta percha and 160 lbs. copper per nautical mile.

The growth of the trunk system since 1896 has been rapid, but it is feared that in providing additional trunks and extended communications, the weight of copper in the aerial lines was for some years rather under-estimated. A more serious point was that the detrimental effect of leading-in points and underground sections was not fully appreciated, with the result that some of the plant erected in the years immediately following 1896 does not meet present-day standards; and this apart from any question of physical deterioration. Other causes have also operated to render line plant, provided many years ago, comparatively less efficient than it was when first erected, even though it may have been meanwhile properly maintained. Twenty or thirty years ago exchanges generally were of a very simple type, the cord circuits were void of complication and the subscriber did more work than now in effecting and clearing a call. The growth in size of local and other exchanges and the greater facilities now given the public, combined with a constantly increasing tendency to "speed up" the service, have involved the provision of very complex cord circuits in exchanges so as to provide for automatic calling and clearing by subscribers and the visual supervision of calls by operators. The loss in transmission efficiency consequent upon the introduction of complex cord circuits, of large multiples, of leading-in points and underground sections in trunk lines, has made it necessary in many cases to replace originally efficient light gauge wires by heavier conductors.

Viewed in the light of our present-day knowledge and experience, the trunk system formed in 1896 was defective in one important aspect from the engineering point of view. It was a framework or structure in which many of the members were out of proportion. Its members were not disposed in such a manner that each should meet its duty in accordance with sound engineering design, and this failing was due partly to (*a*) the fact that the system was an amalgamation of several smaller ones, each of which had been constructed without regard to the part it would play in a national network; (*b*) to the absence of that most important factor, scientific traffic data; and (*c*) to a certain extent, unscientific operating methods.

A scientific method of designing a telephone system has been developed and brought into use during recent years, and will be referred to later; but it may here be stated that such a task is not unlike the design of a lattice bridge, where the duty required from the several members varies with their position in the completed

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design, and they have to be proportioned accordingly. The engineer requires full data of the loads to be borne before he can produce the completed design of his bridge; so also a telephone engineer must obtain full details of the volume and peak load of the traffic to be handled. He must also study the calling rates and the origin and destination of the traffic at the various centres.

One of the most important steps towards the co-ordination of the telephone system in the kingdom was the determination, in terms of miles of standard cable, of the limiting distance of telephonic speech transmission on various types of commercial telephone circuits. The study of the subject of telephone transmission has for many years been one of great theoretical interest, and the writings of Kelvin, Heaviside, and others, have done much to explain the factors that govern the range of possible speech, but it remained for the telephone engineer to apply the theoretical propositions to the practical conditions of commercial use, and in this connection the works of Pupin and Campbell have been of inestimable value.

It is quite possible for experts to carry on a conversation through a circuit having an equated length of 60 miles of standard cable; but the commercial limit of 46 such miles provides a factor of safety such as is common in all engineering design. It must, however, be understood that in order to speak successfully through a circuit which approaches this commercial limit it is absolutely essential that the apparatus shall be in good order, that each correspondent shall speak distinctly and close to the mouthpiece of the transmitter, and that both telephones shall be in apartments or silence cabinets into which extraneous noises do not penetrate. Business men, however, insist upon using a telephone stationed upon or near their tables, and their rooms are nearly always in noisy situations, so that the conditions for a 46-standard cable mile limit are seldom met with and the value of 35 miles of standard cable is now commonly used here and in most other countries as *the* commercial limit.

The general effort is towards an extension of the facilities afforded for one person to talk to another through a telephonic system, and the solution of the problems involved in arranging such facilities is and will be one of the most important duties of the telephone engineer.

The ideal system so far as we are concerned, would be that which would give one person in the British Isles facilities for conversation with any other; but the physical disposition of the area is such that it will be very difficult to provide such a system. Intercommunication between all parts of Great Britain and Ireland respectively would be particularly difficult because of the necessary submarine cable link between the islands.

Much has been done in the matter of improving telephone transmission by loading submarine and subterranean cables, and finality in design and improvement has not yet been reached. With the

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combined results accruing from loading and the use of telephone repeaters, it is not too much to hope that in the future any one person in the British Isles will be able to speak to any other.

To what extent the ideal mentioned can be realized depends largely upon the demands of the public; or, in other words, upon financial considerations.

Since the British Post Office took control of long-distance telephone lines its policy has been to make every subscriber's connection a "long-distance station." This was no easy matter when the trunk lines were first acquired. At that time only a few important commercial centres were directly connected, and from these other scarcely less important towns were served. The large centres became overburdened and the number of switchings and lengths of line involved in effecting communication between subscribers on indirectly connected exchanges, were so great that there was serious waste of time on the long-distance links. As a first remedy traffic studies were made at the large centres, and direct lines provided between points where there was sufficient traffic to fill them. The service was generally quickened and better transmission obtained, with the result that trunk traffic grew. The result of this policy, however, was to produce a large number of pole routes carrying only a few wires. The annual cost per mile of a circuit decreases to some extent as the number of circuits on the route increases. A scheme was, therefore, sought for which would combine the advantages of the direct line policy as regards speed of service, with the economic advantages of multi-circuit routes.

The most promising scheme yet suggested and that at present followed is the splitting up of the British Isles into areas known as Zones. There are nine of these, having their telephonic centres, known as Zone Centres, in London, Bristol, Cardiff, Birmingham, Cambridge, Manchester, Leeds, Glasgow and Dublin respectively. These centres are, or will be, connected together by direct trunk lines of the highest obtainable transmission efficiency. From each zone centre trunks radiate to other secondary centres in the zone, known as "Controlling Exchanges," and from each controlling exchange trunks radiate to still smaller exchanges known as "Minor Exchanges." Junction circuits connect the minor exchanges with the local exchanges in their vicinity.

Such is the scheme for essentially long-distance traffic, but where the load warrants the provision of direct circuits between any two exchanges they are provided.

For purposes of design, rules have been framed which provide that the loop from the zone centre to the controlling exchange shall not exceed the equivalent of 4 miles of standard cable, and that from the zone centre to any subscriber in the zone shall not exceed the equivalent of 10 miles of standard cable plus the equivalent of a 300-ohm

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loop (common battery). There are certain other reservations which need not be mentioned now.

It follows that for a maximum standard cable equivalent of 35 miles between subscribers in a long-distance connection the equivalent of the loop between the respective zone centres should not be higher than 15 miles. All the above values include wiring and apparatus losses.

It is quite possible to design circuits, and many exist, between the zone centres named, having much lower standard cable equivalents than 15 miles, but it is at present impossible, economically, to provide lines in one specific case; namely, lines from Dublin to other zone centres within the limit of 15 miles owing to the necessity of providing a submarine cable. The provision of a high-grade loaded cable across the Irish Sea between Nevin, North Wales, and Howth, near Dublin, has done much to improve London-Dublin communication, and when special land lines have been completed it is hoped to bring this, the most difficult zone to zone connection, below the equivalent of 20 miles of standard cable.

So far as circuits within a particular zone are concerned it is not in all cases possible to keep within the limit of 10 miles of standard cable between the zone centre and the local exchange. Some local exchanges in the more remote parts of the kingdom are about 200 statute miles distant from a zone centre, and to reach such centre there will be at least two exchange switchings involving loss of transmission efficiency. It would be necessary to erect very heavy copper aerial lines to bring such subscribers within the 10-mile range, and the amount of long-distance traffic from such remote and generally sparsely populated districts is insufficient to warrant the expense of providing heavy gauge lines. In these cases the nearest economic value to the 35-mile limit, but less than 46 miles of standard cable, is of necessity arranged for.

There can be no doubt that the more efficient the system or, in other words, the better the transmission, the greater will be the volume of telephone traffic. Further, the greater will be the financial return from any one circuit, since with poor transmission a conversation which takes, say three minutes, might otherwise be completed in two.

The reason for the existence of any telephone company, administration or undertaking as one pleases to call it, is that it has something to sell, namely, telephonic speech transmission; and the requirements of the buyer are that the transmission shall be good, the required connection made speedily and the cost reasonable. In fact the conditions are very much like those obtaining in a large store, the amount of business done depending largely upon the quality of the goods supplied, the ease with which they can be obtained and the price.

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It is essential, therefore, for the telephone engineer in every operation he performs in connection with a circuit to bear in mind what the effect of that operation will be upon the transmission efficiency of the loop, since it is quite obvious that inferior transmission with its attendant inconveniences to the business man must result in a disinclination on the part of the subscriber to use the telephone. The better the transmission the greater will be the tendency of subscribers to use the service and the greater will be the revenue; but on the other hand the provision of high-grade circuits involves higher first cost and annual charges.

The relation between transmission efficiency and plant cost is of primary importance since, given satisfactory operating conditions, it is upon these two factors that the success or otherwise of the system depends. It is generally agreed in this country that telephone service between subscribers joined to exchanges in the same area or neighbourhood is satisfactory if the transmission is not worse than that through 20 miles of standard cable. Naturally two subscribers near one another expect to be able to converse with greater ease than two who are separated by long-distance connections, but these expectations are not always borne out by the facts, owing to long local lengths of unduly light-gauge line.

Transmission standards, as will have been gathered, cannot be regarded as being absolutely applicable in all cases. Whether the general rule can be applied will in each case depend upon the cost of attaining the standard and the revenue likely to result from its attainment. One important point must, however, always be borne in mind in fixing the standard cable equivalent of any circuit; namely, that faults and many other conditions will arise which will cause the efficiency to fall below that which would obtain if the circuit were perfect. There is no balancing factor, that is, nothing can happen to a specific circuit which will increase its efficiency beyond that obtained from the perfect condition. An allowance should therefore be made for what may be termed the "out of condition" state. And this is one of the factors in the determination of the 35 miles as against the 46 miles as the commercial equivalent.

The expenditure incurred annually in the provision and maintenance of telephone plant is very great; much of it in the erection of heavy-gauge copper wires with the object of securing high-transmission efficiency, and it devolves upon everyone concerned with the telephone service of the Post Office to see that the best financial results are obtained from the plant.

With the object of obtaining these results it is essential that there should be the closest co-operation between the officers who are responsible for arranging the services with the subscribers, those who have to design and provide the plant, and those who control the working after the plant has been installed.

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It may be stated at once that the more simple and systematized a telephone system is, the better is the prospect of providing for good transmission. Special services, that is, those not commonly catered for, invariably bring in complications which are detrimental to good service over the system as a whole. The officers who make arrangements with subscribers can assist greatly by discouraging subscribers in their demands for services which cannot be rendered except by the provision of special apparatus or by allowing for a low grade of transmission. A few of the subscribers' services which should be so discouraged are those involving connections to exchanges other than the one normally serving the area in which the subscribers' station is situated; demands for long extension lines to private branch exchanges, and for lengthy tie lines between private branch exchanges. In special cases where long tie lines are provided it should be stipulated that they be used for purely local purposes and that access to the general system of the country should not be obtained over them.

In a very large number of cases the subscribers who ask for such special arrangements do not realize the effect which is produced upon their own service. If it were a matter simply concerning the particular subscriber no great harm would result from providing him with whatever scheme he desired, provided he could speak over it, but when he has access to a common system not only is he himself badly served but so also is everyone with whom he is connected. Complaints result and much time of administrative and executive officers, both engineering and clerical, is subsequently occupied in dealing with correspondence. The cost of this is difficult to assess, but is without doubt considerable. It is, therefore, desirable that the traffic staff should carefully consider and, if need be, consult the engineers, as to the effect upon transmission which is likely to result from the provision of special arrangements.

The officers who are responsible for the working of the plant, also have many opportunities of assisting in obtaining the best results from it. One of the main points they should bear in mind is the proper selection of routes, with the object of reducing the number of switchings to a minimum. Another is to so supervise that listening-in by operators does not take place more frequently than is absolutely necessary for the proper control of calls. Some portion of a mile of standard cable is added to the equivalent of a circuit every time an operator bridges across it, and as will be shown later, a mile of standard cable may be a very costly item. Just as special arrangements in subscribers' circuits debase the general service so also do abnormal or uncommon provisions in exchange equipment, and traffic officers would greatly assist by not asking for devices and the provision of signals which complicate cord circuits. It is possible to design electrical circuits for telephone purposes which give

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very admirable results in the matter of calling, supervisory, and clearing signals; in fact, the circuit can be made to do almost anything but think for the operator, but in general such beautiful arrangements are not helpful from a transmission point of view.

It is upon the engineer that the greatest responsibility for ensuring good transmission devolves. He has not only to provide the plant to meet the requirements, but on account of his special knowledge he must act as adviser to the other branches concerned in the working of the system.

Telephone plant, taken as a whole, is probably the most difficult plant of any to design, construct and maintain. Not only is the telephone itself one of the most sensitive instruments in existence, but the uses to which it is put by any one subscriber vary very considerably. The different parts of the system in the matter of connecting links change in relation to each other with almost every call. A subscriber on a private branch exchange extension may at one moment be connected to another person in the same building by a single local connection, and the next moment may be connected to a subscriber say 200 miles away, in which case there will be quite a large number of circuits joined in series, all of which on the completion of the conversation will be dissociated and possibly each part be again linked up in as many different chains as there are parts. A defect in any one of the parts affects the whole chain of connections.

So far as the lines themselves are concerned and assuming them to be of the proper gauge to give the required service, the matter of greatest importance is to keep them free from noise produced by inductive effects from neighbouring circuits. Quite a small amount of such noise on a circuit will produce as harmful an effect on the transmission efficiency as the insertion in the loop of several miles of standard cable. Interference of this kind can only be avoided by correct design and efficient maintenance.

Maintenance of open lines in this country is probably more difficult than in others, first on account of the general and variable humidity of the atmosphere, and secondly because the roads along which the lines are of necessity erected are very well wooded. These are what might be termed natural disadvantages. The first produces low insulation resistance due to deposition of moisture on supports and internal wiring, and the second a similar result due to wires touching trees. But, in addition, the system adopted for running the wires in revolving squares makes the maintenance of good and uniform regulation more difficult than it would be if the wires were run straight on the cut and cross-over system. Careful consideration has been given to the question as to whether the revolving system shall be abandoned in favour of straight spans with cross-over points. The latter certainly possesses the advantages of greater economy, more ready erection, quicker and easier inspection

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and of somewhat higher transmission efficiency when superposed working is arranged. Low insulation and bad regulation of wires account for nearly all transmission troubles so far as maintenance of lines is concerned. It may be of interest to state here that I have had several trunks erected on the cut and cross-over system, and they are giving every satisfaction.

The most common defect from the design standpoint is the inclusion in the nominal open wire routes of comparatively short lengths of underground cable. Sometimes these lengths are inserted because the route passes through a town, in which case, by the way, the sections are generally long enough to be loaded. In the event of such underground sections being really unavoidable, arrangements should always be made for loading; but every effort must be made to avoid the insertion of underground sections in open routes and to remove those which are already in existence.

In other cases, however, the covered work is provided for the purpose of leading-in to a testing point. On the majority of main routes there is such a testing point about every 10 miles, and in many cases at even shorter distances. The idea of such frequent testing points is a very old one in this country, and most of them were established many years ago in the days when the telegraph held the field; the exponents of the system proclaim its merits from the point of view of rapid removal of faults due to abundant localization facilities, but it is feared they forget that what we have to sell is telephone transmission. With lines properly designed and constructed there should be no necessity to lead in at such frequent intervals for testing purposes. Quite apart from the loss in transmission efficiency produced by the wiring of testing points there is the very real danger of faulty connections on the test board or other such fitting. One such faulty connection, say an ill-fitting plug or link, not infrequently causes a loss in transmission of over 10 miles of standard cable. It is probable that the loss in money due to inferior transmission over these much-led-in trunks is greater than the loss which would be caused by a slightly longer time in clearing whatever faults may arise. Many of the faults which do occur could be prevented if the lines were systematically and conscientiously patrolled. This was the practice in well-organized districts before the transfer of the National Telephone Company's system to the State, but the subsequent rapid growth of the system and latterly the withdrawal of men for military duties have stopped all maintenance inspections and patrols, and lines are now only visited when faults have to be removed. It is to be hoped that on the conclusion of the War inspection work will be resumed on a systematic basis. I have, however, closed a large number of testing points on several main routes, with the result that there has been a considerable improvement in the transmission efficiency without any serious or appreciable counter results. The new system of maintenance testing

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which has been inaugurated on the recommendation of the Maintenance Testing Committee, over which I had the honour to preside, has helped materially in the efforts to cut down the number of testing points.

It is a very common experience to hear engineers (who should know better) say that a particular operation performed on a circuit, such as the making of an additional leading-in point or the provision of some special device in a cord circuit, will only result in the loss of half a mile or so of standard cable. Do they ever consider that 1 mile of standard cable constitutes about 2½ per cent. of the limit of what they are selling? Do they appreciate what is involved upon occasion in reducing the equivalent of a line by a mile of standard cable? To concentrate attention on this point, suppose a telephone circuit be required between London and Glasgow with a standard cable equivalent of 12. It could be provided by wires of 600 lbs. per mile weight, but suppose—and the supposition is not extravagant—that owing to underground sections, leading-in points, low-gauge open sections, apparatus losses and other factors, a loss of 3 miles of standard cable were to result; it would be necessary to erect wires of 800 lbs. weight per mile in order to neutralize this loss. The difference in cost at present prices would be over £8,100 or about £2,700 per mile of standard cable regained by the use of the heavier lines.

It will thus be quite clear that to diminish the equivalent of a line by even a mile of standard cable may mean the expenditure of thousands of pounds. It is unnecessary to labour this point further, but too great an emphasis cannot be laid on the fact that the equivalent mileage of standard cable which is introduced in exchange equipment and by irregular line construction represents a definite sinking of capital, since so much more copper has to be put in the line, or expenditure incurred in loading to compensate for the loss.

Cases do exist, however, in which it is physically and economically undesirable, if not impossible, to provide the necessary number of lines overhead; such include congested local telephone areas, junction routes between large exchanges and certain main routes between towns. In these cases underground work perforce has to be provided, and care should be exercised to arrange that all junction and main line cable routes are improved by loading.

The main cable routes are not intended primarily for long-distance work, but to provide for direct services; they have been laid between such towns as Glasgow-Edinburgh, Manchester-Liverpool, London-Birmingham, and are being completed between London-Liverpool and Birmingham-Liverpool. The number of circuits required to meet direct traffic between the respective places is so great that pole routes are out of the question.

It is worthy of special mention that the London-Liverpool cable, which is loaded for superimposed working has proved a marked success so far as the completed section London-Birmingham is con-

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cerned. It is novel, inasmuch as it contains pairs made up of 200 and 300 lbs. per mile of single conductor respectively. It is the first time such heavy loaded underground wires have been provided in any country, and the success achieved is very creditable to the Department's engineers, who designed the cable and loading, as well as to the contractors who laid and jointed it. As an instance of the damage done to transmission by frequent leading-in of aerial lines and the inclusion of odd lengths of underground, it may at once be stated that the loaded loops in the London-Birmingham and London-Liverpool lengths are better than any of the nominal aerial lines of equivalent gauge between the respective places.

In any telephone administration the cost of the line plant is considerably greater than that of the internal plant; namely, the exchange and subscriber's apparatus. The difference in cost between a highly efficient line and one of lower efficiency is very considerable, whereas the difference in cost between a high-grade instrument, such as a transmitter, and one of lower grade is not very appreciable, being sometimes of the order of one penny. Although the penny may be multiplied many times on account of the number of instruments involved, it pays in the long run to obtain the better type, since a bad instrument may account for a loss as great as 10 miles of standard cable. The present system of obtaining apparatus from various manufacturers under open competition results in a general tendency to lower prices, but care has to be exercised to see that this is not accompanied by a corresponding decrease in efficiency and life. Any saving which may result from purchasing cheap and inefficient instruments, will very soon be absorbed by increased maintenance charges.

It was mentioned earlier that the telephone system now controlled by the British Post Office has been formed by the amalgamation of many different concerns. It is, therefore, only to be expected that there are many varieties of plant in use. This is particularly true of exchange and subscribers' apparatus. The different designs of equipment in use are not, however, wholly due to the above-mentioned amalgamation, they are to a large extent due to the fact that the Post Office is not a manufacturing concern, but draws upon at least five contractors for internal plant. Each of these contractors has a special system to offer, and from sheer necessity of getting the equipment to meet urgent requirements consequent upon growth, widely different types of apparatus have had to be accepted. There are at present the following systems in use :—

Magneto.
Magneto Call Key.
Common Battery Signalling.
Common Battery Nos. 1, 9, 10 and 12.
Trunk, Lamp Signalling.
,, Non-lamp ,,

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The types of apparatus employed differ with each system, and no two manufacturers provide the same system in the same way. Notable cases are the Trunk Exchanges and the Common Battery No. 1 Boards. In the case of the latter there are five distinct patterns, one special to each manufacturer.

Apart from the question of differences in apparatus design, the battery powers employed vary with the different contractors. Some use 22 volts, others 40. All these variations from one cause or another tend towards producing inefficiency in the service.

As regards cost, since a different pattern relay, key, condenser, etc., is required in the various systems and for the different designs of board included in any one system, there is a serious multiplication of stock items and a larger floating stock than would be necessary were standardization carried further. Many items differing in design perform the same functions and there is no clear reason why the best should not be selected and standardized; all contractors being afterwards required to reproduce the standard; nor does there appear to be any need for the voltage to differ in different places. It should be possible to select the best voltage and standardize it with the apparatus.

Healthy competition is of course desirable, but it should be competition in producing the same type of article. It may be argued that to bind all manufacturers by drawing and specification to the production of standard items of plant which, when combined, make up a particular type of exchange board, would stifle development; but this argument, although of some weight in the early or transition days, is at the present moment untrue. Any manufacturer or other person might at any time submit improvements, and these should be the subject of careful study. If the thing submitted proves to be indeed an improvement it would be necessary to consider whether its cost would warrant its being made the standard throughout the country in connection with subsequent works. Obviously the standard pattern must be carefully determined, and it would have to be a radical improvement which would justify an alteration or scrapping of the displaced piece of apparatus. I am bold enough to think the time for standardization has arrived, and some time ago took the initial steps towards securing it. I may further point out that in addition to special apparatus provision consequent upon the use of so many systems, and so many designs, there are special circuit arrangements peculiar to each system and very complex junction circuits have to be devised to enable one design to work in with another—even between exchanges of the same general type. All these complications, and particularly those associated with private branch exchanges, result in considerable losses in transmission efficiency.

Maintenance is also rendered very difficult. The number of

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diagrams of connections with which the maintenance hands have to be familiar in order to deal with faults, is so great as to involve actual strain on all grades of the staff. It is almost too much to expect any of the men to know thoroughly more than a small proportion of the total number of different circuits. This must seriously react upon the speed with which faults are cleared and the general working of the whole service. Added to this the men required to do the work of fault clearance must be of a higher type than would be necessary if the number of different designs were reduced, and it becomes increasingly difficult to arrange for interchangeability in the staff.

One or two different types of exchange must always exist in any telephone system to meet the differing volumes and types of traffic, but there is every reason to urge that the same type of exchange board should always be of the same constitution as regards the design and use of its parts.

It is, therefore, proposed in the near future to fix upon a standard voltage for manual exchanges, to standardize the circuit diagrams and to specify the items to be used. It will take some considerable time and probably involve the expenditure of large sums of money, but such standardization of equipment is one of the main avenues along which general improvement in the telephone service may be sought.

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THE ELECTRIC LOCOMOTIVE.

THE following is an abstract of a paper read at the Institution of Civil Engineers by Frederick William Carter, M.A., A.M.INST.C.E.

The electric locomotive for use on main-line railways has already reached a high state of development in countries where conditions are favourable to electrical operation; the number of distinct types that have been developed is large, and it is somewhat difficult to classify them simply and satisfactorily; development has taken place along two lines, one based on tramway experience, and the other on steam-locomotive practice. Electric locomotives, suitably controlled, are capable of making very efficient use of their adhesive weight for developing draw-bar pull, and on this account electrical operation often shows to advantage where gradients are long and steep. Where such conditions prevail the question of the return of energy to the source, by using the motors regeneratively, becomes of interest.

Electric locomotives admit of a primary division into two groups, namely, those in which the axles are driven independently, and those in which they are coupled and driven collectively. With a few exceptions these two groups correspond with the continuous-current and the alternating-current systems of operation respectively, and have their origin in limitations of motor design. With the exception of the Pennsylvania Railroad locomotives, all important side-rod locomotives have been designed for alternating-current systems. With the exception of the Norfolk and Western locomotives, all driving through jack shafts have been designed to use single-phase commutator motors; with the exception of the later Lötschberg locomotives, all driving through Scotch yokes employ polyphase motors. Two methods are used for driving the axles independently, namely, the geared and the gearless; unless the driving is arranged to be effected through a spring-supported quill, both methods add to the dead weight carried by the axle; the amount of the additional weight is of interest from its bearing on the maintenance of the parts. Collective driving through side rods assumes several forms, but all result in considerable strains in the structure. Where the locomotive is driven by motors of uniform torque the main driving forces cause alternating stresses of low frequency in the structure, but where the driving torque is impulsive the resultant frequency becomes comparable with the natural frequencies of vibration of some of the parts, and at certain speeds

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destructive vibrations are liable to be set up from resonance between the frequency of the main driving torque and the natural frequency of vibration of some part or parts; vibrations of smaller intensity and varying with the adjustment arise from indeterminateness in the application of the driving forces, and such vibrations are also met with in steam locomotives. The polyphase locomotive from its constant speed characteristics is less likely to be affected with vibration troubles than others.

The classification of locomotives according to wheel arrangement has been adopted from steam practice, but hardly affords the same insight as to the type as in the case of the steam locomotive. Electric locomotives have not always been designed with due regard to the question of stability of the rolling motion of the wheels, and some run less smoothly than is desirable on this account. The tilting of the rails and the coning of the wheels causes the progression by pure rolling to assume a sinuous nature, and on the stability or instability of this motion depends the question whether the nosing effect tends to die down or to increase to the limits permitted by the wheel flanges. It can readily be shown that a locomotive carried on a rigid wheel base is in some circumstances unstable and may accordingly be expected to develop a nosing tendency if run at high speed; the same is true when the locomotive is divided into units each carried on a rigid wheel base; guiding wheels elastically centred to align with the main wheels tend, however, to stabilize the motion.

There are few available records of tractive-resistance tests on locomotive-drawn electric trains, but among the most complete are those taken by the General Electric Company in connection with the endurance test on the first New York Central and Hudson River Railroad locomotives. These were made on trains of two different types of passenger vehicle, and are of importance in showing very conclusively that, for a particular type of coach, the additional tractive resistance per additional coach is a function of the speed and is independent of the number of coaches, provided this is greater than two; the additional tractive resistance per additional coach was found to be a straight-line function of the speed within the limits of the tests. The effective locomotive resistance when running with train was found to be smaller than that of the locomotive running alone.

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CORPS ARCHÆOLOGIA.

ROYAL ENGINEERS IN IRELAND DURING THE 18TH CENTURY.

MAJOR J. J. CROOKS, of 35, Brighton Road, Rathgar, Dublin, has been good enough to forward to us the following Memorials, and cutting from the Dublin *Evening Telegraph*, dealing with the status of the Royal Engineers in Ireland during the 18th Century, which will prove of great interest to our readers.

First is a copy of the Memorial of Major James Ferrier, R.E., dated 23rd November, 1789, which reads as follows :—

To the King's most Excellent Majesty.

The Memorial of Major James Ferrier, Engineer,

Most humbly sheweth

That your Memorialist, serving by your Majesty's permission in the Armies of the Queen of Portugal, was by your Majesty's command sent for in the beginning of 1779 by Sir John Irwine, then Comdr.-in-Chief of your Army in Ireland, to come and serve in that Kingdom, with the solemn and specific Promise in your Majesty's Name, that on his Arrival in that Country he should be immediately put upon the Irish Establt. as Major of Engineers, and with that Rank in the Army.

That, in consequence, your Memorialist abandon'd immediately very high Rank and flattering Prospects in Portugal, and on his Arrival in Ireland found, that Directions had been sent to Sir John Irwine to offer your Memorialist only the Rank of Captain of Engineers on the Irish Estabt., which Offer your Memorialist respectfully declined, in consideration of the Promise already made to him, which had engag'd him to quit the Service of Portugal; but it being then time of War and the Army in the field, your Memorialist at the same time offered his Service to the Comdr.-in-Chief as a Volunteer wherever wanted, which offer was readily accepted.

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That, upon the Representation of the above Circumstances to your Majesty by the said Comdr.-in-Chief, Your Majesty was at that time graciously pleas'd to honor your Memorialist with the Rank of Major in the Army, and to signify your Pleasure to the Ld. Lt. of Ireland, by Lord Weymouth then S. of State, that your Memorialt. should be employ'd and paid as Major of Engineers, as he has continued to be ever since.

That, most of the above related Circumstances apper authentically in a letter written by Sir John Irwine to your Memort., which letter is now in the hands of Evan Napeau, Und. Sec. of State.

That, your Memt. has never discontinued his respectful Representations to the different Chief Governors sent to Ireland of the solemn Promise made to your Memt., in your Majesty's Name, requesting to be put on the Estabt. of the Engineers there in consequence, and has always received friendly assurance of the Same from each, particularly from the present Chief Governor both when formerly Viceroy of Ireland, and more especially during his present Administration.

That now at the moment when your Memt. had every reasonable expectation of Promotion from the assurances of the Chief Govr., and of the present Comdr.-in-Chief of your Army there, as well as from the consideration of his having been long at the Head of the List of Majors of your Majesty's Army, and from his having serv'd your Majesty's Crown with zeal and honour ever since the beginning of 1758, to his utter confusion and astonishment, he finds himself by every late Regulation of the Corps of Irish Engineers reduc'd to the Rank and pay of Captain in the same Corps, which appointmt. he respectfully declined near eleven years ago.

That, under the violent Pressure of such extraordinary and unexpected Circumstances and the palpable impossibility of acting as Captain after having been employ'd by your Majesty's direct authority for near eleven years as Major of Engineers, certain of the honourable testimony of all the Superiors under whom he ever served, and brought without his knowledge into a Situation he firmly believes unexampl'd and unprecedented in all the Armies which ever yet existed; your Memorlt. with the most humble and respectful confidence presumes to throw himself and his Situation at your Majesty's feet, imploring from Your Majesty's goodness that Degree of immediate Redress and Relief which the uncommon Circumstances of his Situation so evidently require, and which is so Consistent with your Majesty's well known Principles of Justice Liberality and Protection continually exercis'd towards all the Officers of your Majesty's Army.

And your Memorialist as in Duty bound shall ever pray etc. etc. etc.

J. FERRIER.

Dungarvan in Ireland, Novr. 23rd, 1789.

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Then follows a copy of the Memorial of Lieut. Alexander Taylor, dated 20th November, 1789.

To the King's Most Excellent Majesty.

The Memorial of Lieut. Alexander Taylor

Most Humbly Sheweth

That in the year 1781 your Memorialist then a Lieut. in the 81st Regt. of Foot, was apptd. an Extra Engineer by Warrant and employed under Col. Vallancy in Fortifying Cork Harbour, and has been since employed in assisting to make the Military Survey of this Kingdom under said Col. Vallancy.

That at the conclusion of the War when the other Extra Engineers were struck off, the Govt. thought it necessary to continue your Memorialist on the list of Engineers.

That Yr. Memt. has declined many civil Employments of greater profit, than the pay of Extra Engineer, from a motive of attaching himself to the service of the Ordnance only, in hopes of preferment therein, and that from his Services he had assurance both from the Master-General and the Govt. of this Country, of succeeding to the Rank of Captain, in case of a vacancy, which was then expected.

That in the late alteration in the Engineers of this Country, the Marq. of Buckingham has promoted Lt. Brown from the 27th Foot to be Cap' Lt. over Your Memorialist's head, tho' he was a Lieut. of not two years standing, and Your Memt. has held that Rank twelve years; Your Memorialt. can have the strongest recommendations for his propriety of conduct, abilities, and diligence in Yr. Maj.'s Service, from his C.Os. both in the Infantry and Engineers, and most humbly prays Your Majesty will be graciously pleased to take his case into consideration, and promote him to the Rank of Captain over Cap' Lieut. Brown, which is most humbly submitted.

ALEXR. TAYLOR.

Dublin, Novr. 20th, 1789.

Separate to Ld. Lieut.

That Yr. Memt. has been greatly injured by a late alteration in the Engineers of Ireland.

In conclusion we have a "cutting" from the *Dublin Evening Telegraph* of 4th December, 1915, dealing with the Work by General Vallancy, LL.D.

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When sufficient Subscribers come forward the Work shall go to Press.

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MEMOIR.

LT.-GEN. CHARLES AUGUSTUS GOODFELLOW, V.C., COLONEL COMMANDANT, ROYAL (BOMBAY) ENGINEERS.

BY the death of General Goodfellow at Leamington on the 1st September, 1915, the Corps loses the services of a most distinguished officer whose relations with the old Indian Corps of Engineers were of the most intimate nature.

In the annals of the history of the Corps of Royal Engineers the fact is unique of the grandfather, the father, and two sons having all attained the rank of Colonel Commandant.

The grandfather of the late Charles Augustus Goodfellow was General Samuel Goodfellow who entered the service of the Honourable East India Company's Engineers in 1797. He served at the Siege of Seringapatam in 1799 and in Egypt in 1801, and in the Mahratta War in 1803. He was afterwards for many years Chief Engineer in Bombay. His appointment as Colonel dated from 1829 and as Lieut.-Colonel Commandant from 1825. He was promoted Lieut.-General in 1851, and died in London in 1861.

General William Barclay Goodfellow, the father of Charles Augustus, was the son of General Samuel Goodfellow. He obtained a cadetship at Addiscombe in 1822 and was appointed Ensign in the Bombay Engineers in 1824. He served at Kolapore in 1827, and filled many posts as Executive and Superintending Engineer in the Bombay Presidency. He was appointed Colonel Commandant in 1854. In 1865 he left India, and in 1877 was promoted to General. It is a remarkable and unique fact that for several years the names of the Generals, Samuel and William Barclay—father and son—stood next to one another in the *Army Lists*. The latter General resided at Torquay until his death in 1892.

Charles Augustus Goodfellow, the subject of this memoir, was born at Poona on the 27th November, 1836. In 1853 he obtained a cadetship at Addiscombe on the recommendation of his grandfather, Lieut.-General Samuel Goodfellow, and was appointed Second Lieutenant in the Bombay Engineers in June, 1855. His elder brother, General William West Goodfellow, C.B., was also a very distinguished officer of the same Corps and served in Persia in 1856–57, and in Abyssinia

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in 1867–68, receiving the medals for these campaigns. He became General in 1891 and Colonel Commandant in 1897. At Addiscombe Charles Augustus was noted for his skill and proficiency in athletics, being a good cricketer and football player. He was in the same term with Colonel Charles Henry Luard, Major-General Joseph Bonus, and Colonel George Scott Hills who served in the Indian Mutiny, Bhootan, and Afghanistan. Charles Augustus was renowned for his skill in boxing. On one occasion there was a large fair at Chatham at which several Royal Engineer officers were present. At that time much ill-feeling existed between the officers and men of the Corps and certain roughs who came from Rochester and the neighbourhood and who took every opportunity of insulting them by opprobrious epithets, etc. One of these, within the largest tent at the fair, produced a string of woollen rolls made up like sausages, with which, while walking about the tent, he struck any men of the Corps whom he happened to meet. A regular *mêlée* and free fight ensued, in which Charles Augustus took an active part much to the detriment of those who were unlucky enough to come in contact with him. Some of the men of the Corps who were outside the booth at the time, hearing that the officers were in difficulties, rushed in and cleared the tent of the disturbers of the peace.

Charles Goodfellow arrived in India in 1857, the year of the outbreak of the Indian Mutiny. He served with the Central India Field Force in 1857–58 and was present at the Siege and Capture of Ratgarh, the capture of Garrakota, and the Siege and Storm of Jhansi.

At the storming of Jhansi, Lieuts. Dick and Meiklejohn, of the Bombay Engineers, were killed and Lieut. J. Bonus was wounded. In 1859 he was Assistant Field Engineer with the Okamundel and Kattywar Field Force.

General Goodfellow was awarded the V.C. for gallant conduct at the attack on the Fort of Beyt on the 6th October, 1859. This was the last V.C. of the Indian Mutiny. It was given for uniform gallant behaviour through the war, and more especially at Beyt (Western India) on the above-mentioned date, when under a shower of lead he bore off a wounded soldier from under the walls of the fort.

The Siege of Jhansi was undertaken under such difficulties, and the besieging force met with such opposition that it may not be out of place to refer to some details which are related in the excellent *History of Madras Engineers* by Colonel H. M. Vibart, R.E.

"At midnight on the 19th March, 1858, the force under General Sir Hugh Rose marched to Chuckampore (15 miles), 8 miles from Jhansi, and on the 20th a strong detachment from the 2nd Brigade advanced by a forced march of 25 miles, and placed picquets on all the chief roads round Jhansi.

"Tantia Topee was reported to have left Jhansi for the purpose of bringing down a large army from Calpee—chiefly Gwalior contingent."

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On the 22nd Jhansi was invested by the cavalry. The following extracts are taken from Sir Hugh Rose's despatch :—

"The great strength of the fort, natural as well as artificial, and its extent, entitled it to a place among fortresses. It stands on an elevated rock rising out of a plain, and commands the city and surrounding country. It is built of excellent and most massive masonry. The fort is difficult to breach because composed of granite.

"The fort was extensive and elaborate; outworks of the same solid construction, with front and flanking embrasures for artillery fire and loopholes of which in some places there were five tiers for musketry. Guns placed on the high towers of the fort commanded the country all round. One tower called the White Turret, has been raised lately and armed with heavy ordnance. The fortress is surrounded by the city of Jhansi on all sides except the west, and part of the south. The steepness of the rock protects the west, the fortified city wall with bastions springing from the south face. The mound was fortified by a strong circular bastion for five guns, round part of which was drawn a ditch 12 ft. deep, and 15 ft. broad of solid masonry.

"The city of Jhansi is about 4 miles and a-half in circumference, and is surrounded by a fortified and massive wall from 6 to 12 ft. thick, and varying in height from 18 to 30 ft., with numerous flanking bastions armed as batteries with ordnance and loopholes with a banquette for infantry. To the south are the ruined cantonments and residences of the English. Temples with their gardens, one, the Tokun Bagh, the scene of the massacre of our countrymen, and two rocky ridges; the eastmost called 'Kapoo Tekri,' both important positions, facing and threatening the south face of the city wall and fort."

"I established seven flying camps of cavalry as an investing force round Jhansi.

"The attack on Jhansi offered serious difficulties. There were no means of breaching the fort except from the south, but the south was flanked by the fortified city wall and mound just described."

"The rocky ridge was excellent for a breaching battery, except that it was too far off, 640 yards, and that the fire from it would have been oblique. The mound enfiladed two walls of the city, and commanded the whole of the south quarter of it including the palace.

"It was evident that the capture of the mound was the first most important operation, because it ensured in all probability that of the south of the city, and of the palace, affording also the means of constructing by approaches an advanced breaching battery.

"The desideratum therefore, was to concentrate a heavy fire on the mound and on the south face of the city, in order to drive the enemy out of them and facilitate their capture; to breach the wall close to the mound, and to dismantle the enemy's defences which protected the mound and opposed an attack.

"This was effected, firstly, by occupying and placing batteries on a rocky knoll (the right attack). Secondly, on the rocky ridge there was the left attack.

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"By the evening of the 24th, there were four batteries on the right attack.

"A remarkable feature in the defence was, that the enemy had no posts outside the city.

"Sir Robert Hamilton estimated the number of the garrison at 10,000 Vilaitees and 1,500 sepoys, of whom 400 were cavalry; and the number of guns in city and fort at thirty or forty.

"The manner in which the rebels served their guns, repaired their defences, and reopened fire from batteries and guns repeatedly shut up, was remarkable. The women were seen working in the batteries and carrying ammunition.

"The Garden battery was fought under the black flag of the Fakeers. Everything indicated a general and determined resistance. This was not surprising, as the inhabitants, from the Ranee downwards, were more or less concerned in the murder or plunder of the English."

The despatch of Sir Hugh Rose dated 30th April, 1868, describes in complete detail the operations previous to the assault.

"On the 2nd April orders were given to storm on the morning of the 3rd. The breach was stormed by the left attack, while the right attack escaladed. A feint was made on the west face. About 3 a.m. the storming parties advanced. Right attack (escalading party)—Madras and Bombay Sappers, 3rd Europeans, and Hydrabad Infantry. Left attack—Royal Engineers, 86th and 25th N.I.

"The moon was very bright, and the escalading party had to march 200 yards through a heavy fire. The Sappers with the ladders in three places. Three of the ladders broke. Lieuts. Dick, Meiklejohn, and Bonus* of the Bombay Engineers led the way. Lieut. Dick was bayoneted and shot dead, Lieut. Bonus was hurled down, Lieut. Meiklejohn was cut to pieces, and Lieut. Fox, Madras Sappers, was shot through the neck; but the British pushed on and gained a footing from eight ladders.

"The left attack carried the breach. Street fighting took place in every quarter from wall to palace. Near some stables was found the British flag which had been presented to the grandfather of the Ranee by the British Government for faithful service, and which was hoisted on the top of the palace."

"Street fighting still went on; the rebels fought like tigers, and the bayoneting went on until sunset.

"On the 5th, Lieut. Baigrie, 3rd Europeans, went to the Fort gate, found it open, went on from gate to gate, and found himself in possession of the Fort of Jhansi. The Ranee had fled in the night. Our cavalry went in pursuit and cut up 200. Street fighting still continued.

"On the 6th the last desperate body was disposed of in the Lal Bagh. After four days' hard fighting, Jhansi was ours. The casualties on our side amounted to upwards of 300; of the enemy some 3,000 must have been killed. Forty guns were found in the fort.

* Afterwards Major-General.

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"The father of the Ranee and the Jhansi paymaster were captured by a zemindar, 12 miles to the west, and brought in on the 18th. Both were hanged next day, near the nullah where the massacres had taken place."

Sir Hugh Rose in his despatch says:

"It will be a gratification to the relatives of Lieuts. Meiklejohn and Dick, of the Bombay Engineers, to know that these two young men had gained my esteem by the intelligence and coolness which they evinced as Engineer officers during the siege. I should have recommended both for promotion, if they had not died in their country's cause, for conspicuous gallantry in leading the way up two scaling ladders."

The Sappers' Mess before the battle of the Betwa had eight members; it was now reduced to two.

Lieut. Prendergast* wounded in cavalry charge on 1st April.

Lieut. Fox wounded in storm, by bullet in neck.

Lieuts. Meiklejohn and Dick killed.

Lieuts. Goodfellow and Gordon escaped unhurt.

Lieut. Goodfellow was mentioned in despatches, *London Gazette*, 17th July, 1858, and received the Indian Mutiny Medal with clasp.

At the close of the Indian Mutiny Lieut. Goodfellow in December, 1858, was appointed Acting Adjutant to the Corps of Sappers and Miners and was employed on the Bombay Harbour Defences. As Executive Engineer he acted temporarily at Sholapure from 16th April, 1860. In January, 1862, he was promoted 3rd Class Executive Engineer and placed in charge of the Dewar and Brora Division of the Agra Road. In March, 1862, he was again appointed Executive Engineer at Sholapore, and also at Kanara in October, 1863. He was promoted Captain on the 2nd September, 1864, and was Executive Engineer 2nd Class in charge of Bombay Defences. In September, 1867, he was placed on special duty with the Abyssinian Expedition under the command of Lieut.-General Sir Robert Napier—afterwards Lord Napier of Magdala. During the operations he was employed on the coast in the disembarkation of the troops and other engineering works.

The following is extracted from the account of the Abyssinian Expedition given in General Porter's *History of the Corps of Royal Engineers*:—

"The first step taken was the despatch of a reconnoitring party from Bombay, consisting of five officers, one of whom was Lieut.-Colonel St. Clair Wilkins, R.E., to select the best point on the coast to form the base. This after careful inspection of all the possible places, was decided to be at the village of Loola, in Annesley Bay. Here the water supply of

* Afterwards General Sir Harry Prendergast, Colonel Commandant, R.E.

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the river Haddass promised very fairly, and although the shelving nature of the beach rendered much labour necessary in the formation of piers, no better site could be discovered.

"The first step to be undertaken was the construction of these piers, and from the nature of the beach they had to be of considerable length. No stone was available in the vicinity, the plain being covered with brushwood. Fascines were therefore made use of for the first pier to form retaining walls as a temporary measure, whilst native boats were engaged to bring stones from the opposite side of the bay.

"These when procured, were built into walls outside the fascines, thus giving a character of greater permanency to the piers, which were run out for a distance of 900 ft. into the sea, and even then only gave a depth of 5 ft. at low water. A second pier of similar dimensions was afterwards constructed on piles, the materials for which were brought from Bombay.

"The troops forming the Expeditionary Force arrived by degrees, the advanced brigade landing in November, 1867, and the Headquarters early in January. The Engineer Staff consisted of Lieut.-Colonel St. Clair Wilkins with Capt. C. Goodfellow as his Brigade-Major. There was one company of Royal Engineers (the 10th) under the command of Major Pritchard, R.E. Of Indian sappers there were three Madras Companies, and four Bombay Companies. The Madras Sappers were under the command of Major H. N. D. Prendergast, R.E., and the Bombay Sappers under Capt. Macdonell. Altogether 30 officers of Royal Engineers were engaged in the Expedition."

For his services in the Abyssinian Campaign Capt. Goodfellow was promoted to be Brevet Major and received the Abyssinian Medal. On his return from Abyssinia he was appointed Executive Engineer at Dharwar, Poona District. He was promoted to 1st Grade on the 24th January, 1877, while in charge of the Poona and Kirkee District and at Kanara in July, 1881. In July, 1877, he received brevet promotion to Lieut.-Colonel, and in July, 1881, to Colonel. In May, 1884, he was appointed Superintending Engineer of the Southern Division, and in September, 1887, he was made Chief Engineer for Irrigation and Officiating Superintending Engineer, Central Division. In August, 1888, Colonel Goodfellow was appointed Chief Engineer, 1st Class of the Southern Division. His subsequent promotions were to Major-General, 15th March, 1889, Lieut.-General, 1st April, 1892, and Colonel Commandant, R.E., 2nd February, 1898. General Goodfellow was also Colonel of the 3rd Bombay Sappers and Miners.

After leaving India, he first lived at Sevenoaks, and subsequently, for some years at Leamington, Warwickshire, where his death took place on the 1st of September last.

The qualities shown by the late General Goodfellow when on active service characterized his whole life, for he was ever thinking of others; but his reserve and dislike of publicity were such that his

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many charitable acts are known only to those who participated in them. He was a most devout Catholic and a splendid and upright soldier. His life was a fine example of an individual living for others. He was thoroughly good and kind, and was always ready to devote his time and money to any charitable work. The Charity Organization Society, the Royal Midland Counties Home for Incurables, the Waifs and Strays Society are a few amongst the many public institutions in which he was interested, but his loss will be more acutely felt by those who received the benefit of the innumerable acts of kindness and charity of which his life was made up. To the St. Peter's Boy Scouts he was a real and true friend, and the wounded soldiers at "Holmdene" have in various ways found in him a thoughtful neighbour. His thoughtfulness too was always put into practice; in fact Lieut.-General Goodfellow was a thorough believer in the power of deeds.

Charles Goodfellow was a "thorough sportsman" in the best sense of the term. A first-class shot, with either rifle or gun, he used to spend a considerable portion of his leave, or furlough, in fishing or big game shooting.

His favourite grounds for the latter were the jungles of S. Kanara, south of Bombay. Here he shot a large number of tigers, bison, and other game in the course of his visits spread over a period of several years.

He was an intimate friend of the late Colonel Peyton, the Chief Forest Officer in Kanara, who had shot more tigers than any other sportsman in Southern India.

On one occasion Charles Goodfellow shot a rogue elephant in the Kanara jungles, after patiently tracking it for the best part of two days.

He was also a keen fisherman and spent the best portion of two of his furloughs in salmon fishing in places as far apart as Newfoundland and Tasmania.

Of late years he was unable to do much walking and he usually drove to St. Peter's Church to attend Mass. He and Mrs. Goodfellow found accommodation in their carriage for the wounded Catholic soldiers at "Holmdene." No one was more respected than General Goodfellow, and his death will be a loss in precept as well as example to the community at large.

The fullest possible military honours befitting alike his high rank and valorous career were accorded at the funeral of General Goodfellow which took place at Leamington Cemetery on Saturday, September 4th. That morning at 10 o'clock a Mass of Requiem was said, the Rev. Hamilton Macdonald, M.A., R.N.—a nephew of the General—Naval Chaplain at Portsmouth, being the Celebrant, and the Cantors, the Rev. Fathers McCarthy and McDonnell. Although all the troops in Warwick and Leamington were turned out—

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between 300 and 400 men—the muster would in peace times have been increased to 1,000. The remains of the gallant General were conveyed the previous evening to St. Peter's (Roman Catholic) Church and received at the West Door by the clergy in procession, the Very Rev. Canon Barry, D.D., officiating. The ritual prayers were recited and the body remained for the night in front of the altar rails. On the coffin—which was covered with the Union Jack—were placed General Goodfellow's sword, belt, and medals. These were the Victoria Cross, the Abyssinian Medal, and the Indian Mutiny Medal. The plate on the coffin bore the following inscription :—

CHARLES AUGUSTUS GOODFELLOW.
DIED
1ST SEPTEMBER, 1915,
IN HIS 80TH YEAR.
R.I.P.

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NOTICE OF MAGAZINE.

REVUE MILITAIRE SUISSE.

No. 11.—*November,* 1915.

PERMANENT FORTIFICATIONS AND MODERN ARTILLERY.

It is pointed out in this article that the relative ease with which the Germans made themselves masters of Liège, Namur, Maubeuge and Antwerp at the commencement of the War has destroyed the faith of more than one soldier in the efficacy of fortresses. It might be urged that the places named were, more or less, taken by surprise, their rearmament had not been completed, their garrisons had not been raised to war establishment, briefly that everything favoured the attackers. However, the more recent experience in Poland, where the defence of the fortresses crumpled up almost as rapidly as that of the strongholds of Belgium, seems to suggest that the reasons enumerated above are not the only ones accountable for the comparatively poor resistance offered, in the instances referred to, by the garrisons of fortresses. It is true that examples can be quoted where the results have been of an opposite kind; Przemysl held out for months against the Russians; the Allies spent vain efforts against the Dardanelles position for yet a longer period; finally Belfort, Epinal, Toul, and Verdun have defied all the efforts of the Germans since the beginning of the War, and to-day they stand practically intact, not a stone having been disturbed nor a gun dismounted by hostile artillery fire. Nevertheless, a very general impression prevails that fortresses have not fulfilled the *rôle* expected of them. The experiences of the War in relation to permanent fortifications have been freely discussed in the military Press, and an attempt has been made to account for the apparent failure in this branch of the military art and to discover the remedy which must be applied to reinstate permanent fortifications into favour again.

It is stated that the *Revue* article is based on the ideas contained in articles which have appeared in the *Kriegstechnische Zeitung,* the *Jährbucher für die deutsche Armee und Marine,* and the *Rivista di Artiglieria e Genio.*

The principal cause of the failure of Belgian and other fortresses to play the *rôle* for which they were intended is attributed, in the articles referred to, to the introduction of the modern howitzers and mortars of large calibre, such as the Austrian 12-in. and the German 16·5-in. howitzers. It is claimed that Przemysl only held out as long as it did, because the Russians were not in possession of any artillery as powerful

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as that just referred to. Prior to the Russo-Japanese War, guns of the calibre referred to were only mounted on fixed carriages in coast defences and on battleships. The coast defence and battleship heavy artillery was intended rather to pierce armour plates than to produce any considerable explosive effects. The Germans and the Austrians, with their calculating temperament and being devoid of all false notions regarding idealism and pacificity, set to work to go one better than the rest of the world and quietly evolved the one, the 16·5-in., and the other, the 12-in. howitzer. The former of these weapons, it is said, can project a 2,000-lb. shell with accuracy up to a range of 8¾ miles.

Doubts are expressed, however, with regard to the accuracy of the fire of these weapons at the extreme range mentioned; and it is stated that the illustrations of the effects alleged to have been obtained by the 16·5-in. howitzer have been reproduced for the edification of the public rather than for the information of engineers and artillerymen. However, what is certain is that the projectiles from the 16·5-in. howitzer fired at some of the Belgian forts penetrated 11 ft. 5½ in. into concrete; thus in the contest between artillery and armour plates, as things stand at present, the former is the victor. This state of things will assuredly lead to new developments in relation to permanent fortifications. The 16·5-in. howitzer is practically the heaviest weapon possessing sufficient mobility for use as a siege piece, although more than a half-century ago a 35·5-in. mortar, capable of projecting a 3,300-lb. projectile, was constructed in Great Britain. A weapon which can penetrate 11½ ft. of concrete can, of course, be employed to batter down a masonry parapet or wall possessing three to four times the thickness; questions of time and quantity of ammunition alone are involved. Therefore, no reasonable limit can be fixed upon, as being essential, in the thickness of the mass to be employed to give protection to the guns and the garrison of a work. It is no longer a question of opposing force by force, some other means must be found to meet the new situation.

The great disadvantage of a fort is its immobility which compels it to remain a stationary target for the enemy's fire; it can neither be moved from a very hot corner nor can it, at times, even reply to the enemy's fire—this was often so in the case of the Belgian forts. It is thought that a greater dispersion of the elements of defence works and a measure of mobility in the armament of such works will be sought after, in the future, by those responsible for the preparation of schemes in connection with permanent fortifications.

The armoured cupola has so far by no means come up to expectations; an Italian Engineer officer, however, recently put forward the design for such a cupola intended to resist the projectiles from the Austrian 12-in. howitzers. Its characteristic is an armoured apron jutting forward for several yards under the earthen parapet. In this type of work the cupola and its concrete foundation are, so to speak, isolated and protected against explosions in immediate proximity thereto. The thickness of the armour plating is based on the requirements for resisting a direct hit. Nevertheless, it is thought that the cupola will yield the place to a mobile weapon, provided with a comparatively light shield. Forts

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will continue to lose in importance. An isolated *fort d'arrêt* will probably be entirely a thing of the past, except in mountainous regions; such a work has no chance at all against the modern heavy howitzers of the 16·5-in. type which can be placed in selected positions at a suitable range therefrom.

The fortifications on the Austro-Italian frontier are said to have been designed in accordance with the latest ideas on the subject; so far they have fulfilled the object for which they were provided.

In connection with the Dardanelles Campaign, Turkish mobile batteries have been referred to from time to time, batteries which the Allies have not been able to locate or put out of action. In this case also, it would appear that the Germans and their Allies have studied the situation so thoroughly that as soon as the defects in their defensive arrangements have been discovered they have simultaneously ascertained the most effective remedy. Thus it may be that the works of the Karst and at the Dardanelles may be the forerunners of the fortifications of the future; they embody the principle of smaller and less conspicuous targets and of more mobility for the guns.

It is thought that, in connection with the defence of entrenched camps, detached forts will still be utilized, but that modifications will be introduced in their design. In order to deal with the heavy guns of the attackers, the defenders will require artillery which is heavier still and possesses a longer range than that of the attackers; this artillery, on account of the weight of the individual piece, will necessarily have little mobility and must therefore be placed in forts. Guns of smaller calibre will be placed in the intervals and given the maximum mobility. Therefore, it will become necessary to provide numerous gun emplacements between the forts; the armament for the intervals will be provided with armoured shields and will be moved from place to place, either by mechanical transport along covered ways or along military railways.

The *Revue* has reproduced a diagram illustrating the project for a fort of the future, which was published in the *Kriegstechnische Zeitung* a short while back. The contributor of this design remains anonymous; he lays down the following four conditions as those which must be fulfilled by all *points d'appui* :—

1. They must provide the most effective fire against the enemy during the stages of the close attack.
2. They must support the neighbouring works by bringing the intervals under artillery fire; such artillery to be well protected and defiladed from frontal fire.
3. They must render the point absolutely secure against an assault.
4. They must have internal dispositions so arranged that in the event of an enemy succeeding in penetrating into it, he will find no cover nor be able to maintain his position therein.

The fort in question is shown as having three lines of defence. The advanced line consists of an infantry parapet, immediately in rear of

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which are placed, at 100-yard intervals, armoured blockhouses intended to serve as the base for the active defence and to provide an observation line from which the attempts of the enemy to destroy or pass over the line of obstacles may be prevented. The line of obstacles consists of wire entanglement, about 100 yards deep; it is proposed to charge the wire with high-tension electricity. This entanglement is placed partly on a glacis slope in rear of the infantry parapet referred to above and partly in a V-shaped ditch which is provided with a concrete counterscarp. At 50-yard intervals along the top of this counterscarp are prepared positions, protected with armour plates, intended for the defence of the glacis. The counterscarp is provided with loopholed galleries, from which fire can be brought to bear on any of the enemy who may penetrate into the ditch of the fort, caponiers also being provided near each flank from which the ground along the foot of the counterscarp can be raked with rifle and machine-gun fire. The principal defensive position in the fort is situated some 70 to 80 yards in rear of the counterscarp and consists of an enormous mass of concrete, the top of which is studded with a great number of cupolas for the protection of the machine guns and light fieldpieces intended for use when the enemy has reached within close range of the fort. In rear of the cupolas, just mentioned, and on the flanks of the fort are further masses of concrete upon which are placed additional cupolas for the fieldpieces and machine guns intended for the defence of the intervals and support of the adjacent forts.

The gorge of the fort is shown as completely closed by a continuous concrete mass with cupolas distributed along the top thereof; entrance to the fort being gained by means of subterranean passages at the flanks. Wire entanglement, about 20 yards deep, is placed along the flanks and rear of the fort.

Capt. Tacconi, of the Italian Engineers, has recently prepared a design for a *fort d'arrêt* suitable for a mountainous region. It is said to be up to date; a description of this fort appeared in the *Rivista di Artigliera e Genio* for April, 1915. A brief description of this fort, with a plan, is given in the number of the *Revue* under review. It is pointed out that in a mountainous region the thickness of armour and concrete which can be employed in the construction of forts is limited by questions of cost and transport.

In regions of this kind the forts are often placed behind the crest of some dominating feature providing protection against direct and flank fire. Sites of forts at great altitudes have two defects; mists frequently obscure the field of fire, and snow, at times, interrupts the communications thereto, cutting off supplies of all kinds. These defects are, however, more apparent than real; for with indirect fire, as long as the target can be seen from an observation post, it is of no consequence if the guns themselves are enveloped in a mist. Indeed a mist, at times, may prove to be advantageous as a screen to mask the gun positions. Difficulties in bringing up supplies can further be overcome by attention to details of organization and by the exercise of foresight.

Dominating sites for forts have at all times possessed advantages;

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the value of such sites has increased in recent times, since the greater the altitude at which a fort is situated the less able are the enemy to derive advantage from captive balloons and other aircraft for observation and attack purposes.

Capt. Tacconi's design of a *mountain fort d'arrêt* provides for the principal armament being placed in cupolas, spaced at intervals of 40 yards; these gun positions being connected together by a tunnel in the solid rock and at a suitable depth below the natural surface of the ground, say 18 to 20 ft. to the soffit of the arch over the tunnel. The armour plates of the cupola being little liable to be directly hit by a shell are only of a sufficient thickness to keep out rifle bullets and shrapnel splinters. Ammunition magazines and repair shops are also tunnelled out in the solid rock. The shelters for the garrison consist of bomb-proof casemates, and masonry barricades are also provided to guard against the descent of an avalanche of snow or of loosened rock on to the fort.

Accommodation for the garrison, it is recommended, should usually be placed on the flanks of the gun position, where the men can be made most comfortable and the requirements of hygiene can be best met. Any dead ground, which cannot be swept by the fire of the principal forts, should be brought under fire, either from an auxiliary work specially provided for the purpose, or by special armament installed for the purpose in the adjacent forts, or by mobile defensible artillery.

It is recognized that neither of the examples quoted above can be considered the final solution of the problem; they only give a rough idea of the lines on which the future development of permanent fortifications may probably be successfully worked out. The object should be to provide in ordinary undulating country dispersion and mobility for the armament, and in mountainous country, command and defilade against direct fire.

The opinion is expressed that, except in marshy and mountainous country, the days of small detached forts is past and gone; the present difficulties in transport of heavy artillery are likely to be overcome. It is therefore surmised that the siege artillery of the future will possess a range exceeding that of the German 16·5-in. howitzer, *i.e.*, 8¾ miles. The 15-in. and 16-in. guns hitherto employed exclusively in coast defence works and on battleships have a useful range exceeding 12½ miles. The mysterious weapon with which the Germans have occasionally bombarded Dunkirk during the present war has a range exceeding 23 miles. Small entrenched camps will stand no chance against the siege artillery of the future and in cases where the works are placed on a perimeter, the greatest diameter of which does not exceed 9 to 12 miles, the artillery of the attack may be able to fire, from one and the same position, on the front parapet of some of the forts and on the gorge of others protecting the same centre. For this reason, entrenched camps and fortified centres must in future cover an exceedingly great area and will require enormous garrisons; this will bring about a more intimate relation between the field armies and the garrisons of fortified centres.

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The Serbian Soldier.

This is an illustrated article by R. A. Reiss, who has spent a year with the Serbian Army whilst in the field; he does not pretend to discuss the strategy of the Serbian Army, but only records his personal observations on King Peter's soldiers, as he has found them on the battlefield, in bombarded towns and in camps and billets.

The Serbian Army is recruited on a popular basis and is thoroughly permeated with the democratic ideas which prevail to so large an extent in the Balkan State contiguous to Austria and Montenegro. In the reign of the Obrenovitchs, who were vassals of Austro-Hungary, the Serbian Army was impotent, badly led and ill-armed; the advent of the Karageorgevitchs, descendant of a peasant family of Schoumadia, brought about an entire change in the situation. Democratic government was substituted for the rule by placemen sent by Vienna. Thanks to the efforts of King Peter and his minister, Pachitch, miracles were worked in transforming the Serbian Army into a military machine of considerable value. It is due in a large measure to the foresight of the Serbian Premier that Serbia met with so much success in the late Balkan War and that she has been so long able to hold her own in the present war against the powerful combination directed against her. The organization adopted for the Serbian Army has drawn into the ranks practically every man capable of bearing arms; unfortunately a part of the second ban and the whole of the third ban had not been, at the beginning of the War, provided with uniforms or a proper military equipment; they still wore their civilian clothes, with a policeman's cap. Belts, rifles, bayonets and ammunition pouches were alone issued to them; this was the excuse utilized by Austro-Hungarians for calling them *comitadjis* or *franc-tireurs* and for treating them as franc-tireurs whenever these unfortunate Serbian soldiers fell into their hands. Three successive wars have caused a very considerable drain on the manhood of the nation and on the material reserves of the little State.

By the autumn of 1914, the greater number of the soldiers had worn out their uniforms and were obliged to resort to civilian clothes; nevertheless, the officers and the men in the ranks still bore themselves with soldierly pride, recalling the memory of the glorious soldiers of the days of the French Revolution who fought in rags. The eight months of rest, from January to August, 1915, not only allowed the Serbian soldiers to recuperate in health, but also permitted Great Britain and Russia to provide them with uniforms, great coats and rifles; it must not be forgotten that the Austrians in their flight during the autumn of 1914 abandoned large quantities of military overcoats, pantaloons, etc., which fell into the hands of the Serbians and were a perfect godsend to them. At the time of writing all volunteers and many of the third ban had been supplied with uniforms; the outfits served out were of various descriptions and gave the Serbian Army a motley appearance.

The Serbian soldier is highly disciplined; his discipline is not of an automaton order, but rather one making due allowance for the use of intellectual faculties. Off duty an officer treats his men as comrades

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rather than as subordinates; the soldier often makes the supreme sacrifice on behalf of his officer. The Serbian soldier is proud, without being vain; those of high degree as well as those of low degree are proud to acknowledge that Serbia is a land of peasants.

The Serbian soldier is inquisitive; he wants to enquire into everything. Extreme politeness is shown to strangers, but they are bombarded with pointed questions with a view of eliciting the nature of the particular business in which the stranger may then be engaged. It is not mistrust but curiosity which prompts the questionings.

The Serbian soldiers often possess poetical talent; they are also extraordinarily courageous. The display of courage is noticeable not only on the battlefield, but also in hospitals; soldiers' limbs have often been amputated without the aid of any anæsthetic, yet not a sound has escaped their lips.

The Serbian soldier dislikes nothing more than a retreat; indeed he prefers to make a foolish sacrifice of his life rather than retire from a position. The melancholic disposition of the Slav race is ingrained in the soldier of King Peter's Army; not that he cannot be gay, indeed he can be boisterously so, but when on pleasure bent he carries with him a tinge of sadness. The old soldier of 60 summers and more, belonging to the third ban, is as much to the front as the young soldier in his teens.

Many instances can be given of deeds of valour performed in this war which rank with the heroism of antiquity. The details are related of the manner in which a young soldier named Birtchanine, belonging to a well-known family of Soŭvodagne, met his death in the autumn of 1914, after performing numerous heroic acts, for which he was decorated with the gold medal for valour. About the same time young Birtchanine's great-grandfather was killed by the Austrians because he refused to act as a guide to them.

The Serbian Army possesses a special category of combatants, the well-known *comitadjis* or volunteers, who have been a source of terror to the soldiers of the Emperor Francis Joseph; to-day the *comitadjis* are under military discipline, although they have not been drafted into the regiments of the Serbian Army. The volunteers, who form the *comitadjis*, are young fellows ready to undertake any peculiarly hazardous enterprise and to lay down their lives in a patriotic cause; their spirit will not tolerate the restraint imposed by service in a regiment. They are commanded by officers who are called "*voivodes*."

Those who know the Serbian soldier best ardently hope that he will come victorious out of the present struggle.

A XVII. CENTURY DOCTOR OF VEVEY AS MILITARY WRITER.

Gamaliel de la Tour.

Swiss medical men, it would appear, have in past ages often made a name for themselves outside their own profession; one member of this profession, Gamaliel de la Tour, however, seems alone to have taken any interest in purely military matters, and he acquired, in the XVII.

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century, a reputation as a military writer which has come down to the present time. A few disconnected notes relating to this man's family history, dating from 1404, are given. The date of Gamaliel de la Tour's birth is unknown, but it is on record that he was a student at Montpelier in 1611, and sat for the degree of a Doctor of Medicine on the 26th May, 1615. The doctor does not appear to have had any taste for his profession, so he turned his attention to the military sciences. He wrote two works, both published in 1634, entitled *Abbregé de la discipline militaire et des trois principales actions de la guerre* and *Principes et Fondemonts de l'Art Militaire. Concernant l'Exercise des Armes prattiqué en Hollande, etc.;* they are both exceedingly rare. The first of these works was dedicated "à tous vrays Protecteurs, Colonels, Capitaines, Amateurs de l'Art Militaire." In the first pages of the book, the author counsels the soldier to be on his guard against being overtaken by fear. Apart from the religious strain in which the work is written its contents are very similar to those of the modern Swiss *Instruction sur la service en campagne.* The first part of this *Abbregé* deals with the various branches of the service; the second part deals with the *actions principales de la guerre.* The three *actions principales* are briefly referred to in the following terms:—To house troops is the most difficult, to march is the most painful and to fight is the most desperate and full of peril." The contents of *Les principes et fondements de l'art militaire* are practically the same as that of the present Swiss *Règlement d'exercice pour l'infanterie;* it deals with drill, the manual exercise, etc.

In his *principes*, de la Tour devotes considerable attention to tactics under the title "La Démonstration de l'Exercise concernant la faction ou la manière de se défendre et attaquer son ennemi." Religion also occupies a prominent position in this work; the work contains three prayers, namely for the morning, the evening and the day of battle.

The two works referred to appear to have met with much success, when first published, and were translated into German. G. de la Tour was also the author of a work entitled *Réconciliation et amiable décision des controverses*, published in 1644. It has not been possible for the author of the *Revue* article to inspect a copy of this work and it is therefore not possible to give any indication of the subject of which it treats.

Notes and News.

Portugal.—A special correspondent refers to the operations conducted by the Portuguese troops in Angola against the native levies led by German agents. The Portuguese Governor and Commander-in-Chief did not commence operations against these native levies, who had invaded the Portuguese colony at Naulila and at other points of the frontier, until the reinforcements demanded by him had arrived in the territory under his jurisdiction. Therefore, when he did make a move all the military advantages were on his side and he defeated the natives signally, inflicting very heavy losses on them.

The Portuguese are now engaged in the reoccupation and with the pacification of the frontier region of Angola over which they have recently

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restored their authority. It is reported that a *modus vivendi* has been established between the British and Portuguese Governments as regards the restoration of order in the frontier zones on the two sides of the boundary separating British from Portuguese territory. The part of the country which was in dispute between the Portuguese and German Governments is to be neutralized and to be governed by a mixed Commission composed of members appointed by the Portuguese and the South African Union Governments.

SUPPLEMENT.

The European War.

The examination of the communiqués relating to the present War is continued in the *Supplement* issued with the *Revue* for November, 1915 (for previous notices *vide R.E. Journal* for June, September, December, 1915, and January and February, 1916).

The *Supplement* issued with the previous number of the *Revue* concluded with an account of the bombardment of Dunkirk; the story is picked up at this point in the number under review, and the history of events is completed down to the end of the year 1914.

La Manœuvre.

There was no change in the general situation during the early days of May, 1915. Attacks and counter-attacks producing no very apparent results were announced by both sides in their communiqués. Two exceptionally severe actions were alone referred to in French and Belgian telegrams, the German General Headquarters maintaining silence in relation thereto.

A French communiqué dated 11 p.m., 5th May, 1915, stated that, on the previous evening, French troops had carried a German trench and that the French line had been advanced as far as Lizerne-Hetsas, resulting in the capture of these places. It was announced that the Germans had not counter-attacked; this announcement was premature, for a French communiqué dated 3 p.m. of the 6th May, 1915, adds: "We have easily repulsed, to the north of Ypres, a night attack delivered from the direction of Steenstraat."

The second of the actions referred to began on the night of 11th—12th May, 1915, and was continued during the next few days. Prior to the commencement of this action the German artillery had bombarded the whole of the Belgian front from the east of Dixmude to the sea. To the north of Dixmude the German bombardment was particularly active in the region of the bridgehead established by the Belgians on the right bank of the Yser. Three German battalions made a vigorous attack on this bridgehead on the night of the 11th—12th May. The Belgians drove them back, and at the same time took a number of prisoners. Simultaneously, a Belgian division won some ground to the south of this locality. The Germans returned to the charge on the night of the 12th—13th May, but only to be again driven back.

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These were only preliminary skirmishes; the real effort to recapture the position was begun by the Germans on the 16th May. The French and German telegrams of the 16th, 17th and 18th May relating to this affair are reproduced in the *Supplement*. In the German account of the fighting of the 17th May, contrary to precedent, an unqualified admission is made by the Germans that they had abandoned their advanced positions near Steenstraat and Hetsas; no attempt is made to explain away the retirement by suggesting that the positions abandoned had no longer the same value as when first occupied; nor is there anything to quarrel with in the silence maintained in relation to the four counter-attacks delivered by them.

The situation here dealt with is by no means similar to that on the Aisne where, for example, silence concerning the German counter-offensive gave a quite different impression regarding the nature of the battle as compared with the true facts of the situation; it amounted then to an equivocation. At Steenstraat, the question whether counter-attacks had taken place or not was immaterial; everyone, whether in Germany or elsewhere, would understand that retreat had not been ordered until every measure taken to avoid it had failed of its purpose. Finally, had an excuse been invented the circumstances invoked to justify the retreat must have been of a nature as would carry conviction. Realizing the hazardous position in which it was placed by the Franco-Belgian manœuvre, the German detachment wisely broke off the engagement. This being the first direct admission on the part of the Germans of a repulse, it becomes necessary to account for this departure from past practice. The progress of events may give some clue to the reasons which may have prompted the breaking away from the traditional methods adopted hitherto.

Dampness and fogs interfered with the operations of the belligerents during the period 18th—20th May; even the cannonade of the artillery slackened. Some engagements took place on the 18th May; the Berlin telegrams represented that the results obtained had been favourable to the German arms, but they were referred to in the Paris announcements as two abortive attacks by the Germans which had been held up by the fire from the French trenches. Nothing of consequence occurred on the 19th and 20th May. Activity was resumed during the night of 20th—21st May; there is a complete contradiction in the two accounts relating to this affair. On the 21st May Berlin announced: "The French coloured troops attacked our positions east of the canal during the night. The fight still continues." The French version of the affair is directly the opposite. The Germans had taken the initiative in attacking, but the fight had been brought to a standstill by the French resistance. French telegrams dealing with the situation are reproduced in the *Supplement*.

In view of the fact that the two versions of this affair are in direct conflict, it is necessary to consider which of the two sides had the most pressing motive to make public or to hide the results of the fighting in this region. The matter is hardly debateable, and it goes without saying that the victor would desire to give the greatest publicity to his success,

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whilst the vanquished would make an equal effort to hide his failure. It is not at all likely that the German General Headquarters would have maintained silence had victory been to the German troops. There were reasons, moreover, why the German General Headquarters should maintain a discreet silence regarding the check; one check at Steenstraat had been admitted four days earlier, and there was a danger that the admission of a second check, so soon afterwards, might lead the public to believe that the German front north of Ypres was compromised. This might have proved unfortunate, in view of the very different results expected to follow from the accounts of the piercing of the Allied front in this region on the previous 22nd April. The dissimulation in regard to the final stage of the engagement, in view of the admission that the French had, on this occasion, assumed the initiative and attacked may be thus explained; by maintaining silence in regard to the check, the German public might be induced to persuade itself that "no news is good news" in war as in peace. The enemy had attempted to attack, he had been checked; the fighting continued. What more easy than to maintain silence on the subject for the next few days; the German public should thereupon, without hesitation, conclude that the attack had been finally repulsed. On the other hand, if an announcement were made that German troops had resumed the initiative, it would be impossible to maintain silence as to the results attained; silence in such a case might easily be construed by the public into a reverse.

The second motive for dissimulation lay in the fact that the Germans still desired to regain the passage across the canal. To represent the *rôles* reversed had a double advantage: the situation described indicated that one side had decided to stand purely on the defensive; that this defensive attitude had been imposed forcibly on that side by his adversary. On the German side motives of self-interest dictated that the real situation should be masked. So far as the French accounts are concerned, no apparent advantage would have been gained by representing the French success as arising out of a German counter-attack rather than as the issue of some deliberate operations undertaken on the initiative of the French General Staff. On the contrary, the success would have had a deeper significance had it resulted from deep-laid plans rather than as a consequence of an engagement brought on by the enemy. Moreover, from the point of view of maintaining public confidence, it was desirable to make it clear that the initiative lay with the French.

Calm now reigned on the French front, properly so called; according to the communiqués of the German General Headquarters, up to the 29th May. There was indeed some fighting in the region about Wieltje and Hooge on the 24th *idem*, but this was of interest rather to the British troops. The engagements near Steenstraat seemed to have come to an end. The Germans had withdrawn from the bridgehead on the west bank of the Canal, but had maintained their position on the opposite bank. The engagement of the 29th May brought about no change in the situation.

A Berlin communiqué of the 30th *idem* stated that, after a preparatory

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artillery bombardment extending over a period of six hours, a French attack was launched against the German positions at Houdt-Ferme., *i.e.* the positions in close proximity to the Canal. The losses suffered by the French being exceedingly heavy and the attackers driven back by the Germans, the latter had no choice but to attempt to hold on to the position won by them by the gas attack on the 22nd April—with the exception, of course, of the bridgehead at Steenstraat recently lost. Elsewhere the German troops had been able to hold on to the whole of the positions won by the gas attack aforesaid.

The French account gives a widely different representation of the situation. According to this account, after the affair of the night of 20th—21st May, calm reigned during the two succeeding days. During the night of 22nd—23rd May the Germans returned to the charge at several points between the sea and Arras. The first of these attacks was made to the north of Ypres—to the east of the Canal—but it could not be pushed home. Other attempts were made against the Allies' front between Steenstraat and Ypres during many of the days following; asphyxiating gases were employed, but to no successful purpose.

A new period of stillness prevailed from the 14th to 25th May, but on the 26th *idem*, the Belgian troops repulsed two German attacks to the north and south of Dixmude; on the 27th *idem* an intermittent artillery fight was in progress along the canal front, and three days later the evening communiqué announced that the French troops had carried the whole of the German trenches on Hill 17, in the neighbourhood of Pilkem; they took about 50 Germans prisoners, captured 3 machine guns and repulsed a counter-attack which followed.

Since then, the actual situation, as definitely known to exist, has been found to correspond with that referred to in the French account. The practice of denying reverses is again met with in the telegrams of the German General Headquarters and therefore the admission of the retreat at Steenstraat must be regarded as a single and modest exception to the general rule. It may even be that it is not so much an admission of a check, which should be read into the German communiqué, as indirect praise for the German troops in a tight corner. In another form, it is a repetition of the procedure adopted in regard to the situation at Neuve Chapelle.

Summary and Conclusion.

The positions which the Germans held at the end of May, 1915, were no longer on the line they had succeeded in reaching on the 22nd April. A salient still existed at Ypres, but a salient possessing a less rounded apex. In place of the pronounced semicircle Steenstraat-Langhemarck-Broodseinde-Zwartelen, the salient was formed by a crooked line joining Pilkem-Wieltje-Hooge. The average distance between the positions held by the Allies after and before the gas attack was approximately a couple of thousand yards.

The main incidents of the action may be summarized in the following terms:—German surprise gas attack succeeds on the front Steenstraat-

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Ypres-Stalden occupied by the French. Latter retire from the Ypres-Stalden Railway to the Canal and at Steenstraat behind the Canal. The British troops on the line north of Ypres from Langhemarck to Broodseinde are obliged to conform to the French movement; they take up a fresh position on the line Pilkem-St. Julien-Broodseinde.

These incidents occurred during the period 22nd April to 1st May, 1915.

Deliberate retreat of the British troops; their front is carried back to positions south of the line Pilkem-Wieltje-Hooge. This movement is completed between the 1st and 4th May. British troops forced to retire on Ypres, they succeed in occupying a line slightly in rear of that last mentioned. This double move occurred between the 8th and 26th May.

A French counter-offensive takes place; the Germans are forced to cross to the east of the Canal; the French left, where it connects up with the British front, is carried forward on to the line Streenstraat-south of Pilkem-Hooge. Period 20th to 30th May.

The changes in the fronts occupied at various dates, as indicated above, seem to justify conclusions being drawn similar in all respects to those formed in relation to the engagements in the Champagne. The Germans had won a local tactical advantage which they had been able to maintain, during five weeks of fighting, on the greater part of the front attacked, but not along the whole of it. Some loss of ground won had taken place, on the right wing, where the Germans had been unable to retain the passage over the Canal.

However, although a tactical success was gained the operations really resulted in something of the nature of a strategical reverse. It is pretty certain that the Germans did not undertake this enterprise with the sole wish to push back the front of the Allies just a tiny little bit. They could not have intended merely to smooth out the Ypres salient. The least that they aimed at was to get possession of the Canal and with it to capture Ypres, wherein lay the principal point of passage across the Canal, and if they did not expect absolutely to lay bare their enemy's line of communications, they at least hoped to constitute a serious menace thereto by getting hold of good bridgeheads which would provide good jumping-off grounds for the next step forward; this programme represents probably the minimum which the Germans had set out to accomplish.

The execution of the German plans possessed the advantage that the attacks were convergent; they have drawn attention to this themselves. Recapitulating the results of this action in their official telegram of the 10th May, the Germans claimed that the Allied front which had previously had a length of about 15½ miles and a depth of 5½ miles was after the 4th May reduced to a length of about 8 miles and a depth of 3 miles. It is further stated: "The present positions are still more exposed to the cross-fire of the German Army." This could only mean that it had not been possible to maintain the former front under this cross-fire, it would prove to be still less possible to do so in the more restricted front. The German hopes betray their intentions.

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In order to make sure of success the German General Headquarters did not hesitate to plan the surprise gas attack. This was dangerous. The methods adopted by the chiefs of the German Army in conducting the present war have, too often, done noticeable damage to the character of their army in the eyes of the world; it is not so much the acts themselves as the code of ethics implied by resort to such acts which is largely responsible for this. Those acts are no longer due to occasional errors of judgment, but represent the consequences of a deeply considered plan based on design. The use of poisonous gases has been a part of this reprehensible system. The whole German code rests on the three following maxims of the present-day materialistic philosophy to which the German people cling with tenacity: *necessity knows no law; might is right; the end justifies the means;* or in other words, the attainment of success removes the stain of the most diabolical deeds done to procure the same.

The plan on which the war communiqués are framed also represents an illustration of the last maxim, as do the use of poisonous gases, false accusations alleged against Belgium in order to justify the violation of her neutrality, the alleged shipping of munitions on the *Lusitania* to justify her destruction by a torpedo attack, the firing on German troops alleged against the civil population of Louvain, Senlis and other places as an excuse for pillage and incendiarism. The same idea runs through all these incidents, in spite of the difference in their nature. The use of asphyxiant gases has been held to be particularly serious, really in view of the fact that the insidious treachery involved therein, having been conceived, worked out and practised by the military authorities, conflicts with the code of loyalty which has been honourably associated from time immemorial with the career of arms. This act of the Germans is nothing less than a Jarnac Stroke, yet for many centuries past they had proudly maintained a reputation for honourable conduct. It is tolerably certain that the Germans only resorted to this foul trick in the certainty that their efforts would meet with success and a decisive victory would procure them absolution in respect of the dishonourable means by which the same was obtained.

All the above facts point to a strategic reverse; no doubt, in one respect, one of smaller importance, owing to the magnitude of the operations and the numbers engaged, than the reverses of October and November, 1914, but, on the whole, of greater importance than these latter perhaps, since no better strategic results were obtained than on the previous occasions referred to, in spite of the novelty of the measures adopted to secure success. The second Battle of Ypres represents the end of the German Campaign of 1914 on the Western front; it was the final offensive effort which constitutes the first chapter of the War. This chapter now ends and the last page is turned over at the record of a definite check. The strategic plans develop; the Austro-German General Staff have decided that the decisive offensive must be attempted on a different front.

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The German "Manœuvre Morale."

Seemingly the second Battle of Ypres caused the German Press Service momentarily to rouse itself from the torpor to which it had succumbed: the various phases of the battle were faithfully recorded by it. As a precautionary measure a reference was made to the asphyxiating gas question. At the time that orders were issued for the use of poisonous gases against the Allies, the German General Headquarters published an official communiqué. The public were informed that the British Commander-in-Chief had complained in his reports of the use made, from the time of the capture of Hill 60, of poisonous gases by the Germans in contravention of the laws of war recognized by civilized nations. The communiqué continues: "As the official communiqués have already made known, the enemy have made use of this means of war for some months past. They seem to think that practices which are permissible to them are not so to us. This view has, in the present war, no longer the charm of novelty, and we do not intend, by any manner of means, to have any share therein. But we well understand our enemy's attitude, specially so, when we realize that the German developments in the field of chemistry have naturally put us in a position to make far more efficacious use of these novel methods than can our enemy." This communiqué also deals with the provisions of the Hague Conference of the 29th July, 1899, and points out that it was only projectiles, the *sole* object of which was to liberate poisonous gases, that were forbidden and that the Germans were not using any projectiles of such a kind. It was further claimed that although the German gases were more disagreeable than those used by the Allies, they were not so dangerous; they were only capable of producing more powerful effects.

According to the custom adopted when public opinion had to be educated an official telegram was sent out on the following day, *i.e.*, at the same time as the German announcement of the victory won by means of the gas attack, reiterating the views contained in the communiqué referred to above.

Neutrals were able to learn that the German Press attached considerable importance to the great success at Langhemarck-Ypres. A report emanating from Amsterdam expressed the opinion that the German advance on the Yser Canal had produced great consternation in Great Britain. This advance occurred just at the time that Mr. Lloyd George had announced that Great Britain had troops in the field sixfold as great as at the beginning of the War and the British success claimed at Hill 60 had led the public to expect that the German lines would be pierced shortly. The point at which the Germans had crossed the Canal was very important, being at the junction of five routes. British and French wounded were alleged to have expressed the opinion that the battle was one of the most violent in the course of the War.

Reports of this kind continued to be published for some days; those from Amsterdam were always in the forefront. The *Allgemeen Handelsblad*, it was announced by the German Press Service, had stated that

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the Germans had not awaited the thrust of the Allies promised for the spring, but had themselves made the first offensive stroke by a particularly vigorous attack on Ypres; although they had not succeeded in breaking the French lines, nevertheless they had pushed the Allies' front well back. The *Daily Chronicle* was also quoted to have enlarged upon the character of the German victory.

At the same time, it was necessary that reference to the question of the use of asphyxiating gas should not be overlooked. The conservative section of the German public still had scruples in regard to the misuse of this means in war. Once again it is to Holland that Germany turns for an approving nod. The *Allgemeen Handelsblad* was reported to have expressed the opinion that it was an extraordinary thing to reproach the Germans for having used poisonous gases. According to this paper, war was a terrible scourge and the real question was whether it was not preferable to expel the defenders from the trenches by the use of suffocating gases rather than to blow them to atoms by shell fire. As to the protest of the British Commander-in-Chief, a subject of the former Orange Free State, it was alleged, had written to say that the British had used poisonous gases during the Boer War, and when the Boers complained of this a reply was sent to the effect that this method of conducting war was evidence of the might of Great Britain and that the Boers should be happy to become members of so clever a nation.

The *Nieuwe van der Dag* was also quoted and the paper was represented as holding the view that too much noise was being made concerning the use of poisonous gases, since there was little difference between the use, by the French, of "turpinite" with its poisonous fumes and the use of asphyxiating gases by the Germans.

As a matter of fact, the noise made by the Germans about the gas question was merely trickery; this was known at Amsterdam. The *Tidj* in reviewing the situation wrote: "If the telegrams from the two camps are read with care, one forms the opinion that the Allies find it difficult to admit their defeats."

It has even been suggested that the idea of using asphyxiating gases was, after all, borrowed by the Germans from the British. Lord Dundonald put it forward on several occasions between 1812 and 1846; his proposals were examined by a commission, but rejected, although the efficacy of the method was admitted. Lord Dundonald is said to have advocated the use of gas against Sebastopol, but at that time the execution of his plans appeared impracticable.

The Battle of Ypres was fought at a time when Sir John French felt that he was no longer able to await the French counter-offensive and had, in consequence, ordered the withdrawal of his troops which were, as explained earlier, in too exposed a position. The withdrawal was affected and the battle continued on the new line, but the Germans gained no further ground, and did not achieve the results hoped for as a consequence of the forcing of a passage across the Canal. It thus became difficult to maintain the tone adopted in telegrams since the 23rd April. The official telegrams refer to the bombardments of Poperinghe and Dunkirk, and the German Press Service provides the

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embellishments. This situation disturbed the peace of mind of the military correspondent of the *Daily Mail*. The Western Allies realizing the unfavourable position of their troops at Ypres attempted to regain the ground lost, but the Germans, who had arrived on the east of Lizerne, were only some 7 miles from Poperinghe; their heavy guns however had a range of 8¾ miles at least. The Germans were thus able to bring their guns into action at long range. Poperinghe had been reduced to ruins, but the British ambulances had been able to remove the wounded from the town. Without doubt, the British continued to be disturbed by the course of events. The Rotterdam newspapers published reports of an address given by the Bishop of London in which the heavy British losses and the deficiencies in munitions at the Front were referred to.

In Germany the outlook was considered widely different. The bombardment of Dunkirk loomed larger in the public imagination than that of Poperinghe. The position of the French and British Armies was represented, at the same time, to be precarious, and neutrals were asked to score up points in favour of the German Army. Such was the theme of the German telegrams for several days.

Important results were claimed in respect of the air raid by two Taubes on Dunkirk, just before the bombardment, when 100 casualties were caused by the 19 bombs dropped on the town. Much damage was claimed to have been done to the harbour, etc., by the bombardment itself; many British subjects were said to have been killed and wounded; the civilian population, it was stated, were flying from the town in motor cars panic-stricken, thinking that the Germans had been able to establish their siege batteries within range of Dunkirk.

The *Daily News* account of the effects produced by the bombardment are referred to in the *Supplement*, and the views of the military correspondent of the *Times*, regarding the menace to England which would arise in the event of the Germans breaking through to Dunkirk and Calais, are quoted.

In a general way, the news that Dunkirk had been effectively bombarded at a range of, at least, 24 miles undoubtedly created a deep impression. The first information published in France, which spoke of a naval bombardment, shows that the French were unaware that the Germans had a gun capable of dropping a shell into Dunkirk from the front occupied by them. The Italian papers were also much impressed by the power of the German heavy artillery; the German Press Service made the most of the Italian comments on the subject. Similarly, the most was also made of articles which appeared in the *Daily Express*, *Daily Chronicle* and the *Daily Mail* on the fighting at Ypres, and the use which was made of their views helped to confirm the opinion held in Germany that the stars in their courses were favourable to the success of the German arms.

It was about this time that the counter-offensive was assumed on the part of the French; followed somewhat later by the British forces making good their junction with the French troops.

The high hopes which the Germans had had of piercing the Ypres

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salient were doomed to disappointment, and the *manœuvre morale* had to come to the rescue to cover the German retreat. A Berlin report of the 27th May, 1915, said to be derived from a "reliable source," referred to the favourable impression caused by the situation on the western front; it created not only a reassuring influence, but was also satisfactory. At Ypres slow but sure progress was being made.

The telegraph could, however, afford to let the subject drop. Other events of first-rate importance now monopolized attention; the Battle of Arras began to be seen in its true perspective and the victory in Western Galicia to make its consequences felt. Italy had entered into war against Austria. The accounts relating to the operations round Ypres became of subsidiary importance.

Conclusions on the Western Campaign of 1914.

The German *manœuvre morale* in connection with the second Battle of Ypres was artistic. It adhered closely to the accounts set out in the communiqués, connecting up the episodes of the battle, brightening up the successes, putting a cloak over the slackening off in the operations by expanding accounts of the bombarding of Dunkirk, just at the time when the failure to attain the end in view had become perceptible, helping to throw a veil over the delicate incident connected with the repulse of the offensive stroke at Steenstraat, in rear of the obstacle which it had been hoped to move out of the way, educating the minds of those who might have scruples regarding the use of poisonous gases. More art was shown than at the beginning of the War when the German Press Service set about its work without any refinement and with a confidence born of the conviction that force could intimidate those of every degree and every clime. Reverses had taught their lesson. Not only was the general mechanism of the institution completely changed, as was seen in connection with the *manœuvre des Flandres*; not only did German General Headquarters shift on to the Auxiliary Press Service the responsibility for its own acts; but its demeanour toned down. However, the methods remained the same as at the beginning; neither the German people nor neutrals could be brought to believe that German troops had ever met with a reverse or could ever meet with one. Reverses had always been categorically denied, except in a few isolated cases in which a pure and simple denial was distinctly impossible. It was only in the spring of 1915 that a modification in procedure in this respect took place. Up to this time, the denials had become more and more irreconcilable as the danger of demoralization from the longer duration of the campaign increased. This shows up in relation to the reports covering the period of the engagements in the Champagne, and of those in the Meuse and Moselle region. The instance of Hill 60 is also characteristic. When flat denials became too outrageous, then the plan of toning them down on the lines of the formula adopted in connection with the Battle of Neuve Chapelle was brought into use, *i.e.*, an absurd victory for the enemy; or that brought into use when the offensive on the Yser was checked, *i.e.*, failure covered by "bluff"—

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the bombardment of Dunkirk. An admission properly speaking only occurred as a *manœuvre*, for example as in the retreat across the canal at Steenstraat.

Naturally, irreconcilable denials of reverses were accompanied by claims of success of an incomplete or doubtful character. For example, the deliberate breaking off of an engagement as at Steenstraat is never admitted in the enemy's favour.

Nor was there any essential change in the methods of the French Press Service. A slight change had indeed taken place; from the spring of 1915, there was a greater disinclination to admit reverses than at the beginning of the War. Psychologically this appears logical. Self-confidence had been increasing since the Battle of the Marne and the battles in Flanders; there was now no doubt that sooner or later the enemy would be defeated.

From the German point of view, the second Battle of Ypres ended the campaign of 1914. The *manœuvre morale* on the Western front occupies the period August, 1914, to May, 1915, and the tragedy may be divided into six acts.

La Manœuvre de la Meuse.

The German General Headquarters were confident of an early victory. In this they were disappointed. Germany is the elect among nations and its military chiefs are infallible. It is not necessary for the Press Service to await victories before announcing them; the telegraph anticipates events; the labours of the General Headquarters can bring nothing but success.

The French, on the other hand, were less sure of immediate victory. They had high hopes of ultimate success founded on confidence in a good army, on the assistance of loyal Allies, on a just cause superior to that of the Germans. It was known that the enemy was powerful and that on the last occasion France was at grips with him, he had been the upper dog. The tone and expression of the communiqués were therefore framed in a low key; the alternative of want of success at the start off was not ruled out.

La Manœuvre de la Marne.

The German General Headquarters was still imbued with the idea that it could not err. It had but to complete the victory already more than half won. The principles governing the Press Service remained as heretofore. However, since the actual situation failed to respond to preconceived ideas, and the view prevailed that decisive results would follow shortly, the German General Headquarters, in awaiting more prosperous times, resorted to equivocation and dissimulation.

On the French side, hopes grew stronger; but reverses were too recent and the exercise of prudence was necessary. The principles which governed the Press Service were those of expectancy of favours to come.

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La Manœuvre de l'Aisne et de la Somme.

The German General Headquarters had met with defeat and an extension of time was required to allow for the victories which were yet to come. The resort to equivocation was more marked and the picture of the operations was out of perspective. However, the German General Headquarters declined direct responsibility for the dissimulation; the tone of its communiqués was pitched in a lower key than in the beginning; the Official Press Service of the civil administration became the tool of the military authorities.

On the French side, hope continued to increase in strength, but there were no signs of undue jubilation. Victory was slower in coming than had been expected. The Press Service maintained its former tone.

La Manœuvre des Flandres.

The German General Headquarters began to realize that the early German victories were likely to prove fruitless. There was a still further resort to equivocation; it being supposed that France was already beaten, it was the turn of Great Britain to be crushed. The German General Headquarters shook off from its shoulders still more of the responsibility for the dissimulation. The Official Press Service of the civil administration worked hand in hand with the German General Headquarters and became a mere auxiliary to it, but without any apparent connection with it. Soon there ceased to be military correspondents at the German General Headquarters.

On the French side, there was no longer doubt of a victory, which was further thought to be now near hand. The communiqués referred to the defeat of the enemy in more categorical terms; they raised encouraging hopes regarding the future.

The Winter Campaign.

On both sides, the danger that the lull in the operations during the winter might affect the *morale* of the civil population was fully appreciated. In Germany, the hopes of final victory were postponed; however, territory had been conquered; it was necessary to take all precautions lest the same might be lost. In the communiqués, denials of reverses took place on an exaggerated scale and equivocation and dissimulation were resorted to even in relation to operations of secondary importance. In France, events did not march as rapidly as hoped for; the offensive strokes led to no conclusive results; in the communiqués, the effects of the reverses were toned down, and the periodical reports were framed with a view to creating a more telling effect on the *morale* of the people

The Second Battle of Ypres.

The German General Headquarters made a supreme effort to snatch a victory on the Western front. Experience had taught the Press

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Service to exercise more reticence; it was more sparing with its announcements, but there was no modification in its fundamental methods.

The French Press Service took steps to check an undue spirit of optimism—this had only grown up in the winter; it showed a slightly more pronounced tendency to minimize the importance of those events which were in the nature of temporary reverses. With this exception, its methods remained unaltered.

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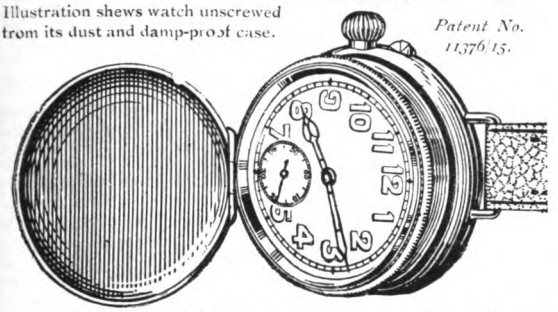

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SHORT NOTES ON SOME EXPLOSIVES.

By MAJOR W. A. J. O'MEARA, C.M.G., *p.s.c.* (Barrister-at-Law of the Inner Temple).

A BRIEF review of an article on "The Technics of Explosives," published in the April number of the *Revue Militaire Suisse* last year, appeared in the *R.E. Journal* for September last. The subject is very fully dealt with in a few standard works devoted to the study of explosives, and much valuable information on the subject also appears in some text-books on chemical processes and also in articles published in various encyclopædia. Further matter has been extracted from the *Revue* article on explosives already referred to earlier and now appears in a form which it is hoped will be found convenient. The headings adopted in these short notes follow generally those forming the framework of the original article.

INTRODUCTION.

The term "explosives" is applied in a general way to certain mechanical mixtures and chemical compounds which, on the application of a suitable stimulus, "explode," that is to say, decompose or change from one state into another—generally from a solid or viscous into a gaseous state—in such a violent manner as to give rise to a rapid disengagement of a great quantity of gas, at a high temperature, in accomplishing this transformation from one to the other state. According to the manner and degree of violence of their decomposition explosives are classified either as "propellants" (Fr. *chassants*) or as "detonators" or "high explosives" (Fr. *detonants* or *brisants*). The difference between these two classes is entirely one of rapidity in the rate of explosion, thus :—

(*a*). In the case of "propellants" the decomposition takes place at a relatively *moderate* rapidity and partakes, therefore, of the nature of a combustion or deflagration. Substances which behave in this manner are, very often, spoken of as powders and are, in popular parlance, known as "low explosives."

(*b*). In the case of "detonators" or "high explosives" the decomposition takes place with *extreme* rapidity; the transformation from the solid (or viscous) to the gaseous state occurs instantaneously and the conversion of the whole mass is produced, not by

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simple combustion, but by the propagation of a kind of shock due to a phenomenon known as the *explosive wave*. In common parlance, the term *explosives* is applied exclusively to substances in this category in contradistinction to the term *powders* employed to distinguish substances possessing ballistic properties.

Some substances are to be found which are capable of both kinds of decomposition, that is by deflagration as well as by detonation, depending on the conditions under which the transformation is effected.

In order to meet practical requirements it is necessary for all explosives to fulfil certain conditions, thus :—

(1). Their constituents must be capable of being concentrated in a small space and must consist of substances which act upon each other with enormous rapidity and independently of a supply of air from exterior sources.

(2). In the process of transformation from the solid (or viscous) to the gaseous state the largest possible volumes of gas must be formed with the development of sufficient heat to create an explosive effect.

It is the almost instantaneous escape of the gaseous products of decomposition from the confined space in which this takes place which gives rise to the explosive effect. The rapidity of the decomposition is in a considerable measure due to the energetic oxygen providers present in all explosives. These oxygen providers consist of the nitrates of metals, ammonium nitrate and a few chlorates, perchlorates, permanganates and chromates. Of the chlorates those of barium, potassium, and sodium are best known and have been experimented with as practical explosives ; the two latter are the most stable and either of them mixed with finely ground cellulose, charcoal, coal, phosphorous, sugar starch, sulphur or sulphides, in certain proportions, yield an explosive mixture. These explosive mixtures are dangerous to manufacture and their storage also presents difficulties ; on account of their tendency to detonate they are quite out of question as " propellants."

Explosives of the " propellant " class, on decomposition, produce a disturbance of such a nature as to project detached substances in their immediate neighbourhood to some distance, whilst those of the " detonator " or " high-explosive " class produce extremely violent disturbances which are very local in character but do not display the property of projecting detached substances to any considerable distance ; it is for this reason that the former class of explosives is found suitable for employment in guns and in firearms for the propulsion of projectiles, whilst the latter class, on the other hand, cannot be so used.

All chemical compounds are either " endothermic " (*i.e.*, characterized by or formed with evolution of heat) or " exothermic " (*i.e.*,

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formed by or pertaining to a reaction which occurs with the absorption of heat). In the former case energy, in some form, is stored up in the process of formation of the compound which is thus raised to a higher potential, as is the case when two elements can only be made to combine under compulsion by the application of very high temperatures, by utilizing an electric current or spark, or under circumstances where a secondary product is formed whilst some other reactions are in progress. The decomposition of chemical compounds belonging to the "endothermic" class is attended with the evolution of large volumes of gas, and this class of chemical compounds on this account provides very valuable materials for the manufacture of explosives. All carbon compounds, except carbon dioxide, and many, if not all compounds of nitrogen, are endothermic. As regards the practical employment of explosives, the manner in which a substance is endothermic is a matter of importance. Mere physical structure may be, at times, responsible for a relative endothermic state. Examples of this are to be found in the cases of chilled steel, glass, etc.: under certain conditions of formation they acquire an internal structure of molecules under a peculiar state of strain, the best known instance of the kind being the glass globules known as "Rupert's drops."

"Exothermic" compounds possess in a certain sense properties which are the reverse of "endothermic"; they are comparatively inert and react either not at all or slowly, and then only if energy is expended upon them from some external source.

Certain explosives when employed for blasting purposes in mines are considered safer than others, and to these the term "safety explosives" is often applied. Such explosives belong, as a rule, to one or other of the two following classes:—

(1). Substances containing nitroglycerin and nitrocellulose; this class consists of weak dynamites, and

(2). Substances containing ammonium nitrate and nitrobenzine or nitronapthalene.

The safety properties of these explosives are largely due to the fact that neither the temperature of the flame produced on decomposition, nor that of the products of explosion reaches the point necessary to ignite fire damp or the coal dust so often present in suspension in a mine gallery after the firing of a shot. Explosives of this class are usually sold under special trade names.

The Explosion.

An explosion consists in a spontaneous disengagement of gas or vapour; oxygen radicals are, as already explained, present in all explosives and by promoting combustion assist the action which

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results in an explosion. Neither high temperatures nor great quantities of heat energy necessarily give rise to an explosion; for example, a reduction of the oxide of iron by thermit (a method employed daily in connection with the autogenous welding of tram rails) is accompanied by a very considerable thermal effect and presents all the characteristics of an explosion; free air is set alight without, however, disengaging the smallest particle of gas; here all the products of the reaction are solids or liquids and in the absence of gaseous products no real explosive action takes place. A simple transfer of oxygen from the oxide of iron to the aluminium takes place, as shown by the following formula:—

$$Fe_2O_3+2Al=Al_2O_3+2Fe+380 \text{ calories.}$$

In no case will a similar reaction cause an explosion. On the other hand, the ordinary combustion of a substance can, in some cases, be so accelerated by increasing the area of contact between the combustible and an oxygen radical as to result in an explosion. This acceleration in combustion may take place by design, as when benzine vapour is intimately mixed with air and exploded by means of an electric spark in order to develop pressure on a piston for the purpose of actuating a motor; unfortunately, it may also come about accidentally, as when illuminating gas, petrol vapours, vapour of methylated spirits, etc., become mixed with air within a building and are ignited unintentionally with disastrous consequences. In mines similarly fire damp, as is well known, is the bane of miners and engineers.

Explosive decomposition always requires the intervention of a more or less energetic exciting agent to start it off. This exciting agent may be merely a warm body put into contact with the explosive; it may also have its origin directly in an ignition by flame or electric spark, in a rapid raising of temperature by frictional action or otherwise or in a shock caused by a blow (as of a hammer, etc.); it may even be produced *indirectly by an explosive wave* generated by a percussion cap. In certain cases light, that is to say the ultra-violet rays, may give rise to violent explosions by bringing about an energetic chemical combination of two gases or substances, as for instance that of a mixture of chlorine and hydrogen. In darkness, the two gases last named combine very slowly, but when excited under the influence of ultra-violet light rays a brusque combination is effected with the disengagement of heat resulting in the formation of hydrochloric acid.

The mere fact that a breakage of a receptacle containing some substance has occurred is not necessarily evidence that an explosion has produced this disintegration; for example, when a closed cast-iron bomb with thick walls is filled with water and plunged suddenly into a mixture of ice and salt (at – 18° C.), the walls of the bomb

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break up into fragments resembling those produced by an explosion; in this case it is the expansion of the water in the act of freezing which brings about the breakage of the walls of the containing vessel, and this occurs although no disengagement whatever of gas has taken place. There are, of course, many instances where the contrary is the case, as when the boiler of a locomotive bursts or a tube containing liquid carbonic acid explodes; in the instances last mentioned, a spontaneous disengagement of vapour or of gas is brought about, although no chemical action has taken place. In what follows in these notes, only explosions produced by some chemical reaction will be dealt with; since explosions of this nature alone affect the study of modern explosives, therefore those arising from other causes may here be entirely ignored.

The Propagation of an Explosion.

In the case of the explosion of powders—which in some instances must be suitably confined in an enclosed space in order to produce an explosive effect—the propagation takes place by contact; the application of a flame or light at one point starts a combustion, disengaging enough heat to raise the neighbouring particles to the temperature at which reaction commences. The character of the combustion of powders is eminently favourable to the gradual development of pressure in the breeches of guns and rifles and, in consequence, the use of these substances as "propellants" permits projectiles to be ejected from guns and rifles with high initial velocities, without causing excessive stresses in the breech of a weapon in which the powders are exploded. In practice, each grain of powder burns during the whole period of travel of the projectile in the barrel of the weapon—in the case of heavy pieces of artillery this period may amount to $\frac{1}{10}$ of a second and more. In the arrangements made for firing the powder the aim in view is to set it alight over the whole of the surface of the charge simultaneously.

The propagation of the detonation of a "high explosive" takes place differently and much more rapidly than the explosion of a powder. The reaction is here started at one point and produces the *explosive wave* to which reference has been made earlier in these notes. This wave spreads out with very great rapidity to each particle of the explosive substance lying in its path. Even where interstices exist in the physical structure of the substance, so long as these are not large, the detonation is communicated by *influence* across the gaps formed by the interstices in question. The velocity of explosive waves has been measured by utilizing long tubes filled with the explosive substances under examination in such a manner as to bring about the rupture of two electric circuits; the velocities so ascertained have been found to vary from 1,000 to 8,000 metres per second and exceed those produced by the explosive waves of

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powders. An explosion can be effected by *influence* at a distance of some metres. A case is on record relating to an explosion by *influence* which occurred on the Rhine in 1895; in that instance a boat laden with 18,680 kg. (about 183 tons) of dynamite blew up off Schurpole and caused a spontaneous explosion of 150 kg. (about 3 cwt.) of dynamite on board a vessel moored in the stream at a distance of 22 metres from the scene of the main explosion; another vessel, carrying explosives, was lying some 20 metres beyond the one on which the subsidiary explosion occurred, but in spite of its proximity to the two explosions referred to its contents escaped unharmed. Apart from the colloidal powders all explosives are more or less sensitive to shock. It is these qualities which render "detonators" or "high explosives" unsuitable for use in guns and rifles for the propulsion of projectiles, and consequently their use is confined to that of bursting charges in high-explosive shells, bombs, torpedoes, and mines, and for the purpose of carrying out demolitions.

COMPOSITION AND MANUFACTURE OF SOME OF THE BETTER-KNOWN EXPLOSIVES.

The explosives actually employed at the present day are nitrogen compounds and consist of mechanical mixtures, such as gunpowder and some chlorate compounds, the ingredients of which separately are, in some cases, non-explosive; chemical compounds employed singly, the chief of which are fulminate of mercury, guncotton, nitrocresols, nitroglycerin (in the form of dynamite, trinitrotoluene, and picric acid (in the form of lyddite or mélinite); combinations of explosive compounds, as for example, cordite and the other "smokeless" propellants now so extensively used for military purposes; finally, the blasting and detonating or igniting compounds used for mining and a variety of other purposes. The present-day propellants consist essentially of nitrates of some organic compounds, and may theoretically be considered as being nitric acid the hydrogen of which is replaced by a carbon complex. Nitroglycerin and guncotton belong to this group. Another large group of explosives is formed by a more direct attachment of nitrogen to the carbon complex: many explosives of the detonating type belong to this group, nitrobenzene ($C_6H_5NO_2$) being one of the longest known of the group. The composition and manufacture of some of the better-known explosives are given in outline below:—

Black Gunpowder.—Gunpowder is undoubtedly the oldest explosive mixture known. It consists of an intimate mechanical mixture of potassium nitrate, sulphur, and charcoal; the exothermic reactions involved in the oxidation of the carbon and sulphur by potassium nitrate are responsible for the energy developed on the explosion of gunpowder. The proportions in which the constituents are mixed

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have varied slightly both in the United Kingdom and on the Continent of Europe; in some parts of the Continent the proportions used are, 78 per cent. of potassium nitrate (KNO_3), 10 per cent. of sulphur and 12 per cent. charcoal. At the present day, the proportions of the several constituents in black rifle powder is 75 per cent. of potassium nitrate, 10 per cent. of sulphur and 15 per cent. of charcoal. When the size of artillery weapons commenced to grow, it was found that the gunpowder, then employed exclusively as a propellant, burnt too rapidly and the size of grain was, by degrees, increased in order to decrease the rate of combustion until it grew to the large pebble powder, consisting of 1¾-in. cubes. This change, however, did not produce the effects desired, so that later developments led eventually to the introduction of *hexagonal* prismatic powder, provided with a longitudinal perforation in the centre of each hexagonal prism; the combustion is started with this powder in the central cores and thus uniformity of burning of the whole charge is secured. Still later, when the 80 and 100-ton guns were introduced further modifications became necessary and were secured by increasing the percentage of potassium nitrate and charcoal and decreasing the percentage of sulphur; for instance, in "Cocoa" powder the ingredients are 79 per cent. of potassium nitrate, 2 per cent. of sulphur, 18 per cent. of charcoal and 1 per cent. of moisture. On the other hand, in the case of blasting powders the generation of large volumes of gas within a relatively short space of time is required and this is obtained by increasing the proportion of sulphur and this incidentally augments the inflammability of the gunpowder. Blasting powder usually contains 67 per cent. of potassium nitrate, 19 per cent. of charcoal and 14 per cent. of sulphur. The chemical changes which take place on the explosion are very complex and vary according to the ingredients composing the same. The nature of the chief changes may be gathered from the following equation:—

$$16\ KNO_3+21C+7S=13CO_2+3CO+16N+5K_2CO_3+K_2SO_4+2K_2S_3$$

The manufacture of gunpowder involves the preparation of pure potassium nitrate, distilled sulphur and charcoal, and the mixing of these ingredients intimately so as to form a homogeneous mass. The ingredients of the desired quality having been obtained, the charcoal and sulphur are ground separately and screened and mixed with moist potassium nitrate in a mixing machine, consisting of a gunmetal drum and stirrer. A "green charge" is thus obtained; it is sifted and then passed into an incorporating mill—consisting of iron or stone runners revolved at a short distance above the plate of a large iron or stone pan-like receptacle. The mixture is kept moist whilst in the incorporating mill; on completion of the incorporation process the "mill cake" is broken up by being passed

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between gunmetal rollers and then pressed into cakes in gunmetal boxes lined with wood. The "press cake" is now passed between toothed rollers (this process is known as "granulation"), and the granulated cake is next graded by sieves. The grains are then glazed, that is to say given a polished surface, being for this purpose rotated in drums with powdered graphite. To remove dust and complete the process, the powder is finally dried and finished by being further rotated in a cylindrical frame covered with canvas. In the case of "prismatic" powders, the "press cake" is cut either by hand or by rollers provided with knife-like ridges into the desired shape.

Black gunpowder on being fired from a gun gives off finely divided solids equal to nearly half the weight of the charge; these solids form large clouds of smoke. For this reason when rapid-firing guns and magazine rifles were introduced it became necessary to introduce some form of "smokeless" powder.

Smokeless Powder.—A discovery was made that the rate of combustion of nitro-cotton could be slowed down by destroying the structure that existed in nitro-cotton by gelatinizing it with alcohol and ether, and led to the invention of smokeless powder. Smokeless powders vary very little from one another in their composition, their usual ingredients being 98 per cent. of guncotton, 1 per cent. of acetone and 1 per cent. of mineral salts and moisture.

The nitro-cellulose in a finely divided state is dried out at a high temperature then treated with alcohol. It is next triturated with a solvent in a kind of kneading machine. The paste thus obtained is cut up into bands or ribbons, and after the elimination of the solvents these bands or ribbons are next cut up in a special machine either into short rods or into tablets; in this state they are somewhat unstable and otherwise dangerous by reason of the fact that when the pieces are shaken together, electrostatic phenomena are readily produced by the mere friction caused by the motion of the surfaces against one another. These disadvantages can, to some extent, be got over by polishing the rods and tablets and coating them with graphite by rotation in special drums. The powder is then ready for use.

Cordite.—The discovery was made, in 1875, by Nobel that when a low form of guncotton is macerated in nitroglycerin, the guncotton is gelatinized, all structure disappears, and both explosives are so tamed as to become a suitable basis for a smokeless propellant. Later, an improvement on this was thought out by Abel and Dewar who ascertained that the highest form of guncotton, which is unacted upon by nitroglycerin, could be converted into a gelatinized mass if a common solvent, such as acetone is used to reduce the mixture to pulp, and afterwards evaporated out. This blend consists approximately of 65 per cent. nitrocellulose, 30 per cent. of nitroglycerin

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and 5 per cent. vaseline; the last-named ingredient being added to increase the stability of the explosive and also to lubricate the gun. The "Mark I." cordite contained 68 per cent. of nitroglycerin; the heat of combustion in guns using this quality of cordite was so great as to give rise to a troublesome form of erosion, which very considerably shortened the lives of field guns.

The Germans and Austrians employ a smokeless powder of a very similar kind to the cordite used in the British service, but the French are using a smokeless powder made by gelatinizing nitrocotton without any nitroglycerin.

Mercuric Fulminate ($HgC_2N_2O_2$).—This explosive is a salt obtained by the action of alcohol on a solution of nitrate of mercury in nitric acid and is prepared by causing 10 parts by weight of nitric acid (Sp. Gr. 1·4) in the cold to act on 1 part by weight of mercury: this solution is heated to 55° C. and poured into 8·3 parts by weight of methylated spirit. An extremely violent action ensues, the fulminate separates into crystals and these are filtered off and washed. The resulting product is a white crystalline powder and, although liable to detonate readily by friction or on the slightest shock, it is one of the most useful high explosives known. Mercuric fulminate can be tamed by adding to it at least 10 per cent. of water; its detonation temperature varies between 150° to 200° C. The decomposition of mercuric fulminate into its elements is expressed by the equation:—

$$HgC_2N_2O_2 = Hg + C_2 + N_2 + O_2 + 62{\cdot}9 \text{ calories.}$$

However, since the carbon and oxygen combine to form CO, with liberation of heat, the actual energy developed on its explosion is greater; the nature of the changes is perhaps more accurately represented in the following equation:—

$$HgC_2N_2O_2 = Hg + 2CO + N_2 + 114{\cdot}5 \text{ calories.}$$

In both the above equations the products on detonation are gaseous; owing to the large volumes of these gases as compared with those of the substances from which they are generated, exceedingly high pressures can be obtained if these gaseous products are confined in a space previously completely occupied by the substances from which they are evolved.

Mercuric fulminate forms the chief ingredient in cap compositions, detonators and fuses; in the case of caps for military cartridges mercuric fulminate is usually mixed with a small quantity of potassium chlorate or nitrate.

Nitrocellulose or Guncotton ($C_{12}H_{14}O_4(NO_3)_6$).—Guncotton of ideal purity is cellulose hexanitrate, but various lower nitrates are found

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in the guncotton manufactured for commercial purposes. The process of manufacture is as follows :—Waste from cotton spinning mills is thoroughly freed from grease and dried at a temperature of 100° C. The cotton is next plunged in charges of from 1 lb. to 2 lbs., for a few minutes, into a cast-iron vessel containing a mixture of 1 part by weight of nitric acid (Sp. Gr. 1·5) with 3 parts by weight of sulphuric acid ; it is then withdrawn, placed on a grating and compressed to get rid of surplus acid. The charge is now placed in a covered stoneware jar, which is placed in a stream of cold water for 24 hours ; at the end of this time the nitration is complete. The cotton is placed in a centrifugal machine for the purpose of removing the bulk of the acid, the greater part of the remainder being washed away by a stream of water in a paddle machine to which the cotton is transferred, prior to its further treatment in a centrifugal drier ; this part of the process is completed by subjecting the treated cotton to two boilings by steam. The guncotton is then thoroughly pulped, the pulp being afterwards washed in a paddle machine ; in this state it should not give off nitrous fumes on the application of heat, and a small sample is accordingly placed in a test tube, with a piece of paper, moistened with potassium iodine and starch, and heated to 65° C. in order to ascertain that no fumes are given off capable of separating the iodine. If imperfectly washed, the trace of acid left renders the gunpowder liable to spontaneous decomposition and explosion.

For industrial purposes guncotton is generally sold in a loose state, but for military purposes it is compressed into discs and slabs. As dry powder it can be detonated by means of a percussion cap, or by shock (iron on iron) ; in a wet state, containing about 25 per cent. of its own bulk of water, it constitutes a safety explosive which can only be detonated in contact with a suitable proportion of dry guncotton, and it is therefore usually stored with a moisture context of about 30 per cent. Dry discs and slabs of guncotton being very friable they are, as a rule, coated with paraffin wax. Ordinary undried guncotton is, at times, dipped in a solution of sodium carbonate and carbolic acid to prevent the growth of fungi on it.

Guncotton ignites spontaneously at about 150° C. ; it burns fiercely when kindled in an unconfined space. Its decomposition on explosion is represented by the following equation :—

$$C_{12}H_{14}O_4\ (NO_3)_6 = 7CO_2 + 5CO + 8H + 3H_2O + 6N.$$

On explosion guncotton gives more heat and more gas than an equal volume of any kind of gunpowder.

Colloidal guncotton is a mixture of the di-, tri-, tetra-, and penta-nitrates of cellulose. Weaker acids are used in its manufacture, but

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in other respects the processes are similar to those employed in the manufacture of ordinary guncotton.

Nitroglycerin ($_3H_5$ $(NO_3)_3$).—Nitroglycerin is glyceryl trinitrate and is prepared by the action of a mixture of the strongest nitric and sulphuric acids (in proportion of 1 : 2) on anhydrous glycerin (Sp. Gr. 1·26). The mixture of acids is cooled and run into a leaden vat provided with a coil or worm of lead piping through which cold water is continuously circulated. Glycerin is slowly sprayed into the mixture of acids by compressed air; the temperature of the mixture meanwhile being carefully regulated so as not to exceed 30° C. in order to provide against the risk of sudden decomposition, or even an explosion. The nitration takes place very rapidly, and when the temperature has fallen, the contents of the vat are run into a settling tank. The viscous explosive collects in a layer above the acids; it is separated off from the latter by decantation and carefully washed, first with water and finally with dilute alkali so as to remove residual traces of acid, as these are liable to cause spontaneous combustion. The manufacture of nitroglycerin is dangerous and ought to be carried out only with apparatus of suitable design; furthermore, the acids and other materials should also severally be of the purest quality. Nitroglycerin is a colourless oily liquid (commercial samples, however, often possess a yellowish tint), with a sweetish taste and toxic properties: it is insoluble in water, volatilizes at 100° C. and solidifies at 8° C.

In handling this explosive care must be taken not to subject it to shocks, since very slight ones are capable of producing formidable explosions. It is for this reason that nitroglycerin cannot be utilized singly, but only in combination with other bodies. It is one of the most powerful explosives known at the present day; on explosion it yields the following products:—

$$2(C_3H_5(NO_3)_3)=6CO_2+5H_2O+6N+O.$$

Nitroglycerin is a more rapid explosive than guncotton, and although it gives off more heat than does the latter, on the other hand it gives off less gas. The fumes produced on the explosion of nitroglycerin and its compounds are often poisonous, probably owing to incomplete detonation.

Dynamite.—This explosive consists of nitroglycerin absorbed by some inert substance. The absorbent most usually employed is kieselguhr, a siliceous earth; chalk, charcoal, cork, kaolin, magnesia and mica have also been used, but do not give such satisfactory results. The proportion of ingredients is 75 per cent. of nitroglycerin and 25 per cent. of kieselguhr (or other absorbent); these ingredients are thoroughly mixed by hand and form a plastic mass which is passed through a sieve and finally pressed into a continuous rod of dynamite. The continuous rod is cut up to form charges of

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suitable dimensions, these are wrapped in waterproof paper and then form the so-called dynamite cartridges. In water, the porous siliceous earth becomes dissociated from the nitroglycerin and absorbs the water instead. Dynamite when kindled in small quantities can be burnt without an explosion, but if a large quantity is set alight the critical temperature of explosion is reached and it will then detonate; it is a powerful explosive and a dangerous one. The common dynamites freeze at a temperature of from 6° to 8° C. and are then comparatively safe for transport. At very low temperatures dynamite again becomes somewhat sensitive to shock. In a frozen state dynamite cannot be effectively exploded with the ordinary detonators, and it must therefore be thawed before being brought into use, an operation requiring considerable care owing to the liability of an explosion in the event of this explosive being heated by improper methods.

Nitrogels, or Explosive Gelatines.—These explosives are mixtures of nitroglycerin and guncotton; they are capable of resisting ordinary shocks without exploding, but not the impact of bullets or other projectiles. These compounds are non-hygroscopic, and burn in ordinary air without exploding. Blasting gelatine consists of 93 per cent. of nitroglycerin, absorbed by 7 per cent. of nitrated cotton, and is made by heating nitroglycerin in a copper vessel, to a temperature not exceeding 35° C., whilst at the same time small quantities of finely divided nitrated cotton are added, from time to time, the mixture being stirred the whole time. At the expiration of 60 minutes or so, the mixture becomes converted into a semi-transparent viscous mass. It is sensitive to shock when in a frozen state, but in its normal state it is more difficult to detonate than dynamite; it possesses another advantage over the latter in that it can be used under water. One kilogramme of blasting gelatine liberates 1,530 calories on explosion. Gelatine dynamite, another variety of this type of explosive, contains 65 per cent. of a thin blasting gelatine, 26·25 per cent. of potassium nitrate, 8·4 per cent. of wood meal and 0·35 per cent. of soda; many other varieties also exist.

Picric Acid, or Trinitrophenol ($C_6H_2 \cdot OH \cdot (NO_2)_3$).—This substance, consisting of yellow crystals which attack most metals chemically (iron and lead to a high degree, tin and aluminium scarcely at all), is a nitro-substitution compound and is the main constituent of mélinite as well as lyddite. The compounds of picric acid with metals, such as the potassium salt, ($C_6H_2 \cdot OK \cdot (NO_2)_3$, are easily detonated by friction or percussion when dry and always when heated. Picric acid is formed by heating phenol or carbolic acid ($C_6H_5(OH)$) with sulphuric acid in an iron vessel to a little over 100° C.; when cold the resulting phenol-sulphuric acid is dissolved in twice its weight of water, and then added to three times its weight

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of nitric acid, precautions being taken to prevent an undue increase in temperature; when fuming has ceased nitrification is completed by the application of steam heat. On cooling, the crystals of picric acid are precipitated and are purified by recrystallization when required. Three atoms of the hydrogen in the original phenol are replaced by the radical nitryl, and the acid in combination with metals forms a class of salts known as "picrates" which are extremely sensitive to shock, although picric acid singly is a very safe explosive. Picric acid is readily soluble in alcohol and ether, but sparingly so in cold water. Its melting point is 122·5° C. The interiors of shells and other iron containers for the explosives of which picric acid is a base should be tinned or provided with some other coating to prevent direct contact between the iron walls of the shell or container and the explosive charge. It is an explosive producing violent disruptive effects, but it requires either to be enclosed and heated, or to be started by a powerful detonator in order to obtain its full effect; its *explosive wave* is propagated with a velocity of 7,500 metres per second. Melted picric acid can be poured directly into a shell or cast into any desired shape; when so cast and compressed it is much more stable than in the crystalline state.

Trinitrotoluene or Trotyl ($C_6H_2 \cdot CH \cdot_3(NO_2)_3$).—The disadvantages inherent in the use of picric acid led to investigations which resulted in the discovery of trinitrotoluol, or T.N.T. as it is now termed; it is obtained by the nitration of toluene and consists of crystals which are precipitated at a temperature of from 77° to 79° C. Crude benzol contains 36 per cent. of toluene and this is separated by careful fractionation of the crude benzol, the boiling point of toluene (Sp. Gr. ·869) being 110° C. and intermediate between those of benzene and xylene. The toluene used for the manufacture of trinitrotoluene should be a clear white liquid and free from solid matter in suspension; it is first converted into the mono-nitro compound; next it is treated with nitric acid at a slightly increased temperature to convert it into the dinitrotoluene, and this is finally nitrated in a sulphuric-acid solution with strong nitric acid to trinitrotoluene. Its manufacture on a large commercial scale is effected by a sulphonating process from the orthonitroluene similar to that employed for the manufacture of picric acid. Very pure materials are obtained by recrystallization; in this case beautiful yellow crystals are precipitated at a temperature of 81° C. Trinitrotoluene when pure has no odour; it darkens on keeping. In some ways it resembles picric acid but has the advantage over the latter of being insensible to shock, powerful detonating caps being necessary to detonate it; further, it is perfectly stable and not being of an acid nature it has no strong affinity for metals, and so does not form compounds with them, this being the case even when moisture is present. When

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heated to 180° C. it burns readily, giving off a thick black smoke. It should be noted that the salts of the nitroaphthols ($C_{10}H_6 \cdot OH \cdot NO_2$) and the products of higher nitration formed in combination with metals behave much like the "picrates."

Ammonal.—This explosive consists of from 12 to 15 per cent. of T.N.T. mixed with an oxidizing compound, ammonium nitrate, a little aluminium powder and a small quantity of charcoal. The rate of detonation of ammonal is not so great as that of trinitrotoluene, but its destructive effect is far greater than that of the latter; its only drawback is the hygroscopic character of the ammonium nitrate, requiring the mixture to be made up into cartridges capable of excluding moisture. Other constituents of tar are converted into explosives by nitration, thus dinitrobenzol is the basis of "Roburite" and "Bellite," whilst trinitrocresol has been also largely used under the name of "Ecrasite"; this latter possesses the disadvantage of having an acid reaction and of forming sensitive compounds with a number of bases.

Acetylene (C_2H_2).—Acytelene is an endothermic compound evolved when calcium carbide (CaC_2) is brought into contact with water, thus:—

$$CaC_2 + 2H_2O = Ca(OH)_2 + C_2H_2.$$

When the gas is compressed under at least two atmospheres, it can be detonated either by means of a fulminate cap or of a platinum wire raised to incandescence by an electric current. The decomposition is then represented by the following equation:—

$$C_2H_2 = C_2 + H_2 + 61{\cdot}4 \text{ calories.}$$

Acetylene in the liquid state constitutes an exceedingly dangerous type of explosive, its decomposition being effected by a dissociation of the constituent gases—it liquefies at a pressure of 80 atmospheres at 18° C. In the gaseous form it burns with a flame of high illuminating value.

Potassium Chlorate Powder.—Potassium chlorate is a salt which is a by-product in the manufacture of alkali by the Leblanc process, free chlorine being essential for its production; it is anhydrous and used in the manufacture of explosives as an oxidant. When the potassium chlorate is mixed with sulphur and carbon, or better still with sugar, a powerful disruptive explosive is obtained. These very dangerous powders have been studied by Turpin, who has sought to diminish the danger of explosion by shock by embedding the chlorate in a tarry mixture.

Cheddite.—This explosive consists of chlorate potassium powder incorporated with a solution consisting of an admixture of nitrotoluene and oleo-resin. It is used, principally, for blasting purposes in mines.

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Generally speaking, mixtures of chlorates with aromatic compounds, such as the nitro or dinitro-benzenes ($C_6H_4(NO_2)_2$) or even napthalene, form exceedingly powerful blasting agents; the violence of the action in these cases being primarily due to the rapid evolution of oxygen, and to the fact that it is possible to detonate a chlorate when alone. To the latter fact is attributable the use made of chlorates to form the basis of firing mixtures and friction tubes. The dinitro-benzenes in admixture with ammonium nitrate produce a blasting powder of a "flameless" type which on account of its safety properties, is valuable for use in gassy or dusty mines. Explosives can also be manufactured from the sodium and potassium perchlorates and permanganates but these are not so sensitive as those obtained from the chlorates. Powerful and sensitive explosives can also be produced by combining metals, such as aluminium and magnesium, in the form of fine powder with perchlorates and permanganates; some compounds of chromic acid with diazo compounds and some acetylides also provide highly powerful and sensitive explosives, whereas bichromates only provide feeble explosive mixtures.

Heat and Energy Generated on Explosion.

An examination into the calorific power of explosives reveals the astonishing fact that the heat generated by them on decomposition is exceedingly small as compared with that furnished by the ordinary combustibles. Thus, the heat given out by 1 kilogramme of petrol when consumed by burning is 12,000 calories, the same quantity of crude oil furnishes 8,000 calories, of dry wood 3,500 to 4,000 calories, whilst a kilogramme of dynamite on decomposition only gives out 1,300 calories. The latent energy of explosives is far from being as great as that attributed to it in the popular mind; as developers of heat, their efficiency factor is miserably low, but what is of value in them is their property of parting with this latent energy in an extraordinarily short space of time. Thus 1 kilogramme of nitroglycerin on decomposition furnishes 1,600 calories, approximately 650,000 kilogrammetres, during $\frac{1}{1000}$ of a second, that is to say it develops 8,660,000 H.P., or in other words power equal to that which the Falls of Niagara are capable of furnishing.

The energy developable by an explosive depends solely on its calorific power; what this power is can be ascertained experimentally in any particular case by the ignition of a small charge of the substance under examination in a calometric bomb. A suitable pattern of calometric bomb for this purpose consists of a cylindrical vessel, with thick strong walls, having one end permanently closed; a stout cover which can be screwed on or off is provided for the other end, and leads passing through it are connected to a spiral of fine platinum wire, this spiral being enclosed in the cylindrical

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vessel when the cover is screwed on. The substance under examination is placed inside the calometric bomb; its cover having been securely screwed into position, the bomb is placed in a copper vessel containing a known quantity of water and provided with a stirrer for maintaining uniformity of temperature throughout the mass of water surrounding the bomb. The copper vessel is then placed inside a receptacle of felt or other non-conductor of heat, so as to be well enclosed therein. A thermometer having been placed in the water the platinum spiral is raised to incandescence by means of an electric current; thereby the substance under examination is ignited. The heat generated during the decomposition of the substance is communicated to the walls of the bomb and thence to the surrounding water. The increase in the temperature of the known quantity of water having been read off on the thermometer inserted therein the calorific power can be calculated by means of the following formula (knowing that quantity of heat required to raise 1 kilogramme of water 1° C.=1 calorie) :—

$$\text{Calories} \times 425 = x \text{ kilogrammetres.}$$

When the thermal change which takes place on explosion in a suitably-designed apparatus, and the volume of gas generated are known, the total possible pressure can be calculated from experimental data available. The number of heat units (calories) furnished and of the energy generated per kilogramme* of substance by some explosives is given in the following table :—

Substance.	Heat Units. Calories.	Energy. Kilogrammetres.	Gas at 0° C. and 760 mm. Litres (=61·025 cu. in.).
Explosive gelatine ..	1,640	697,000	—
Nitroglycerin	1,580	671,500	715
Dynamite (75 per cent.) ..	1,300	552,500	—
Guncotton	1,100	467,500	860
Cocoa powder	830	352,750	200
Mélinite	810	344,250	—
Large grain rifle powder ..	720	306,000	275
Blasting powder	510	216,750	360
Fulminate of mercury ..	410	174,250	—

The above figures clearly bring out the fact that mélinite and fulminate of mercury owe their value as explosives entirely to their detonating properties, that is to the extraordinary rapidity with which their decomposition is effected.

Numerous tests and experiments have to be carried out in order to investigate the properties of an explosive. One method of comparing the relative values of different explosives consists in exploding a small quantity of the substance when placed in a cavity, provided

* 1 kilogramme=2·205 lbs.; 1 kilogrammetre=7·235 ft.-lbs.

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for the purpose, in the longitudinal axis of a cylindrical block of lead (known as Trautz's block). On decomposition of the substance the lead yields and the cavity is consequently enlarged; a comparison of the volumes of the cavities before and after the detonation gives a measure of the explosive power of the substance under test. In some cases, explosives give rise on decomposition to exceedingly great pressures, and even to pressures which are too high to be measured; in such cases the substance under investigation must be entirely enclosed.

From the point of view of safety, it is further necessary to study the effect of heat on explosive substances; this is done by raising the temperature of the substance by definite successive steps, in order to determine the temperature at which it will ignite or commence to disintegrate. The temperature of spontaneous ignition, obtained by this method, has been ascertained in the case of certain explosives to be as follows:—

Fulminate of mercury	160°—165° C.
Guncotton	183°—186° C.
Dynamite	180°—200° C.
Nitroglycerin	160°—220° C.

It is often merely a question of temperature which determines whether a particular substance will simply burn away or decompose by detonation. An experiment to illustrate this fact consists in allowing nitroglycerin to fall, drop by drop, on to an aluminium plate heated over a Bunsen jet; as each drop of nitroglycerin comes into contact with the heated plate it bursts into flames, but when the temperature of the plate is lowered to a certain critical value, the explosive detonates with extreme violence.

To complete the investigations into the properties of an explosive substance delicate tests have to be carried out to ascertain its sensitiveness to shock, friction, humidity, cold, etc., and the data thus obtained allow a record to be prepared of its characteristics. Such a record affords a means whereby any particular explosive substance can be identified and the uses to which this substance can be put to be ascertained; this record, therefore, constitutes an indispensable complement to the data obtained by chemical analysis.

Conclusion.

It is by no means possible to state definitely which is the best of the high explosives; probably the most powerful explosive is one made by converting benzene into anilin, and by nitration transforming this into tetranitro-anilin. Recent experiments have also proved that explosive alloys can be formed with rhodium, iridium and ruthenium; these alloys evolve heat when dissolved in zinc, and a solution of the rhodium zinc alloy when treated with hydro-

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chloric acid leaves a residue which undergoes a change with explosive violence if heated in vacuo to 400° C. It would be extremely difficult to produce a substance having greater explosive force than those already discovered and in use at the present day; however, it is a matter for speculation whether more powerful explosives could not be obtained by combining acetylene with liquid ozone although, taking practical considerations into account, it appears almost impossible suitably to effect this combination. Whether any advantages would be gained by the discovery of explosives which are more powerful than those already in use is another matter. So far as "propellants" are concerned the corrosive action on the lining of a gun or rifle largely limits the use of explosives which are otherwise suitable from the point of view of their ballistic properties, whilst in the case of "detonators" or "high explosives" once it is possible to plant them on to the exact spot at which it is desired to effect destruction, such destruction can be effected with as great completeness by the employment of one of the present-day "high explosives" as with any new one which may be discovered. On the other hand, any increase in the "safety" properties of "high explosives," and improvements in other directions tending towards facilitating their transport would be a gain from a military point of view.

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SEWAGE PRECIPITATION.

AT a meeting of the Society of Engineers (Incorporated), held on March 6th, Mr. Reginald Brown, M.INST.C.E., M.I.MECH.E., F.S.I., F.R.SAN.I., read a paper entitled, "Sewage and its Precipitation: Facts and Fallacies from Laboratory and Practical Tests." Taking three of the best-known chemicals in general use, viz., ferric sulphate, sulphate of alumina, and lime, the author pointed out that engineers needed to be fully acquainted with the value of precipitants, and warned them not to expect that a precipitant which was suitable and economical for one sewage must be equally effective and economical with another, or under different working conditions. The composition of sewage varied at different works, and even at the same works at different times, but the practical outcome of treatment in tanks was to reduce to the lowest possible limit the organic impurities present in the sewage and so to relieve the natural or artificial filters provided for the oxidation of the tank effluent.

The author laid down as an axiom that to compare the value of precipitants the purification figure for suspended solids should be calculated on *settled* sewage, and not on *crude* sewage as was generally done, because some of these solids would deposit of themselves by reason of their specific gravity, and did not absolutely require chemicals for precipitation where tanks of sufficient extent are provided to take advantage of this factor. Referring to the experiments carried out at Dorking by the Royal Commission on Sewage Disposal, it was shown that the work of chemicals, if calculated on the crude sewage figure, would be represented by 69 per cent. purification, whilst on partially settled sewage (from continuous flow tanks) the percentage was only 29. The value of chemicals was also felt in aiding the precipitation of colloidal matters which clogged the filters. A point the author desired to emphasize was the want of a standard form in which chemists should return their analyses, and he gave examples of varying expressions of analyses of the same material by different analytical chemists. Working tests on ferric sulphate, ferric sulphate and lime, and sulphate of alumina and lime were then described; and also the manner in which the chemicals were applied to the sewage, the class of sewage dealt with, and the works for which the tests were carried out. The following figures were quoted to show the comparative percentage purification obtained by the various chemicals :—

	4 Hours' Oxygen Absorption.	Albuminoid Ammonia.	Suspended Solids.	Colloids.
Ferric Sulphate	41·86	25·61	80·6	16·0
Do. and Lime	43·2	37·7	80·0	19·3
Sulphate of Alumina and Lime	57·2	48·4	91·2	40·1

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Figures were also given to compare the results obtained by ferric sulphate alone, and sulphate of alumina and lime, by first settling the sewage and comparing with the averages obtained from the tanks in the practical tests. The sulphate of alumina and lime showed a greater improvement than the ferric sulphate alone.

The author then set out to show from figures that tests in the laboratory on a single large sample of one day's crude sewage treated with the two chemicals did not agree with the actual working results. By means of a chart the analytical results were compared, the costs remaining constant, from which it is seen that although ferric sulphate is a fair precipitant, sulphate of alumina and lime is the best for the particular sewage experimented upon and for the particular method of treatment adopted.

The summary of results showed that laboratory tests must be checked by tests on a practical scale before any definite line could be followed or any definite statement made as to the value of a precipitant, and that a laboratory test is only sufficient in so far as it gives results under ideal conditions which are by no means met with in actual practice of sewage disposal.

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Colonel R. H. Vetch, C.B., Royal Engineers.

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MEMOIR.

COLONEL R. H. VETCH, C.B., ROYAL ENGINEERS.

ROBERT HAMILTON VETCH was born at Birmingham on 6th January, 1841, his father being at that time Resident Engineer of the Birmingham and Gloucester Railway Company. Both his parents were Scots; his father being the third son of Robert Vetch, of Caponflat, Haddington, and his mother the daughter of Robert Auld, of Edinburgh.

Among the many memoirs of Corps worthies which Vetch contributed to the *Dictionary of National Biography* was one of his father, who was a remarkable man and had a varied career. James Vetch was commissioned as second lieutenant in the Corps of Royal Engineers on 1st July, 1807, and took part in the Peninsular War. He joined Graham's force at Cadiz in 1810, and was present at Barrosa. In 1812 he had a share in the storming of Badajoz, and his letters describing the assault are quoted in Porter's *History of the Corps*. These and other letters written by him during his service in Spain were printed in the *R.E. Journal* in 1880 and 1881. After the end of the war he was employed for some years on the Ordnance Survey; but promotion was slow, and in 1825 he went on half-pay, and turned to civil engineering. He paid special attention to marine work, and put forward a plan for a ship canal across the Isthmus of Suez. From 1846 to 1863 he was Consulting Engineer to the Admiralty on questions affecting harbours. He died in 1869 having had ten children, of whom two—Robert and his younger brother William Francis, rose to high rank in the Army, though neither of them saw war service.

Robert Vetch was educated at the Grammar School, Henley-on-Thames, and at Hopkirk's School at Eltham, and after passing through the R.M. Academy he was commissioned as lieutenant, R.E., on 23rd December, 1857. He was under 17 years of age, yet he was second in a batch of 14, Charles Warren being next to him. The two became warm friends in later years. Sir Charles writes:—"At Chatham I did not see much of Vetch in 1857–8 as our difference of age told, but I always had a great respect for him as a consistent Christian. . . . He was the most consistently Christian man I have ever met—always the same for sixty years, from his boyhood at the Shop—without ever degenerating into sentimentalism. . . . Some persons are so infernally opinionated that they cannot discuss a subject; Vetch and I, even when we differed very much, could go on discussing subjects all the day long because each stimulated the other to think at his best."

After being two years at Chatham, on the Establishment and on the District, Vetch went to Shorncliffe, and in November, 1861, he was ordered to the West Indies. He spent nine months at

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Bermuda and then went to Barbados. There he became engaged to Marian, daughter of the Deputy Commissary General, George Darley Lardner, a son of Dr. Dionysius Lardner. They were married in the summer of 1863 at St. George's Church, Dominica, having gone there as guests of the Governor. From Barbados they went to Trinidad.

They returned to England in October, 1864, and Vetch was sent to the Western District. He was put in charge of the new defence works for the Bristol Channel—on Steep Holm, Flat Holm, and Brean Down—and lived at Weston-super-Mare. It was a responsible duty for a subaltern; and Colonel J. W. Savage, R.E., who was with him there, speaks of the ability, tact, and sterling common sense with which he carried it out, adding that his even temper and charming manner made it a pleasure to work under him. After about three years at Weston, Vetch was moved to Plymouth, and was employed on the defences of Plymouth Harbour.

In the summer of 1869 he was chosen to report on the laying of the French Atlantic cable from Brest to St. Pierre, and thence to Duxbury Cove, Massachusetts. He went out in the *Great Eastern*, which was the principal cableship. He wrote a very detailed report of what occurred day by day, and afterwards brought together the more important particulars in the *R.E. Professional Papers* for 1870 (Vol. XVIII., New Series, pp. 137—162). It is a good example of the thoroughness with which he did his work. He remained in the Western District seven years and a-half, becoming second captain on 30th July, 1869. In April, 1872, he was sent to Malta where he remained till the end of 1876. That was his last foreign service. It added to the experience in practical fortification which he had already gained at Bermuda, the Bristol Channel and Plymouth.

In January, 1877, Vetch became Secretary of the R.E. Institute. It was then in its first youth and needed good guidance. As editor of the *Professional Papers*, it fell to him to start a new series—*Occasional Papers*, to be brought together into volumes; and in the first volume he reviewed the history of the Corps publications from their inception forty years before. As Secretary of the R.E. Corps Libraries he brought out a new and improved catalogue in a handier form, and he made the books at Headquarters more accessible. He was also Editor of the *R.E. Journal* which soon showed a marked improvement in quality and get-up as well as an increase in size. He was very successful in getting good articles, and he had a high standard and sound judgment. He held his appointment at the Institute for seven years, much to the advantage of the Corps. He was promoted major on 16th February, 1878, and lieut.-colonel on 14th September, 1884.

Vetch remained at Chatham till the end of that year, and for a time he commanded the Submarine Mining Battalion. In December he went to the War Office as Assistant Director of Works for Fortifications, a title changed some years afterwards into Assistant

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Inspector-General of Fortifications. On 1st July, 1889, when his term of staff service was drawing to an end, he became Deputy I.G.F., owing to Colonel Durnford's resignation, and he held that appointment till 5th November, 1894. Consequently he had ten years of continuous service in the Fortification Branch, during the latter half of which he was Secretary of the Defence Committee, and of the joint Naval and Military Committee on Defence. It was a busy time in that branch. Works for the defence of the principal coaling stations abroad were in progress, and others were under consideration for our commercial harbours at home. Defence by submarine mines was being developed. The forts and batteries built in the sixties to guard the chief military ports were no longer a match for the guns carried by ships, and needed remodelling as well as rearming. As one who had the good fortune to serve with him for five years, the writer can testify to the value of Vetch's personality at this time—his powers of work and prompt decision, his clear-headedness and fearlessness, his sound judgment and equable temper. In recognition of his services he was made C.B. in 1894. He had become brevet colonel on 14th September, 1888, and substantive colonel on his appointment as D.I.G.F.

On leaving the War Office he went to Dublin as Colonel on the Staff and Chief Engineer in Ireland. Lord Wolseley was then Commander-in-Chief there, but was soon succeeded by Lord Roberts. The most important matter to be dealt with was the improvement of the Irish barracks. The Royal, Portobello, and Wellington Barracks at Dublin were reconstructed, and new cavalry barracks were built at the Curragh under the Barrack Loan ; and the Military Works Loan which followed included many Irish items. To meet civil exigencies, Vetch was sworn as a J.P., like other senior officers. He did not hold his staff appointment for the full term, for he reached the age of 57 on 6th January, 1898, and was placed on the Retired List. He was given a Reward for distinguished or meritorious service.

After his retirement he lived in or near London, and found employment for his pen. Even during his busiest years he had written a good deal. About 1888 Dr. William Hunt, the historian, introduced him to Leslie Stephen, the Editor of the *Dictionary of National Biography*, and from that time onward Vetch was a highly valued contributor to that work. He concerned himself especially with R.E. officers, and took care that the Corps should have its due place in this assemblage of our foremost men. He wrote 183 articles (about 360 pages) in the *Dictionary*, and others in the supplementary volumes. His writing, says a very competent judge, was facile, direct, and invariably intelligible at first reading. He was a contributor also to the *Encyclopædia Britannica*. For the 10th edition he wrote 30 articles on distinguished soldiers, British and foreign ; for the 11th edition he wrote an account of military affairs in Egypt and the Sudan from 1885 to 1900.

He did some biographical work on a larger scale. In 1901 he

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published the *Life, Letters, and Diaries of Sir Gerald Graham*, and in 1905 the *Life of Sir Andrew Clarke*, under whom he had served at the War Office. He was the author of *Sir Charles Warren and Spion Kop: a Vindication by "Defender"* (1902), in the writing of which he had to restrict himself to documents already published, so that he could not state his case with full effect.

In 1900 he published a reprint of Gordon's own narrative of his campaign in China, which originally appeared in Vol. XIX. of the *R.E. Professional Papers* (N.S.) under the title "Notes on the Operations round Shanghai in 1862–4." As an introduction to it, he gave a brief but lucid account of the origin and history of the Tai-ping rebellion.

Vetch was always ready to undertake work for the benefit of the Corps, and he was the sort of man to whom people turn when there is such work to be done. He was elected one of the trustees of the Widows' Society on 15th June, 1901, but he had been a member of the Decennial Committees of 1879, 1889 and 1900, to investigate the position of the Society; and he was also a member of the Committee of 1909 which, after very thorough examination, recommended an increase of the bonus by £5. He continued to the end to take a keen interest in the management of the Fund.

In the summer of 1909 he left London and took a house near Kew Gardens, from which he moved six years afterwards to Ilchester, Kew Road, Richmond. He was suffering much from arthritis at the time, and after a very painful illness of more than six months he died there on 28th January, 1916. He was buried in Highgate Cemetery, where his father had been buried. His wife survived him, and the writer is indebted to her for assistance freely given in spite of illness. They had eight sons and six daughters, of whom six sons and five daughters are living. Three of them are married and there are eight grandchildren.

Dr. William Hunt, whose friendship with Vetch began at Weston 50 years ago, says of him:—"Vetch was an extremely pleasant companion and I much enjoyed the days spent with him at the works. He was invariably cheerful, full of humour and energy. He stuck at his work and did not care to go to parties as he said they would interrupt him. He lived frugally. . . . Vetch always struck me as happily combining in his character firmness and resolute will with gentleness. He was a man of high principle yet ready to make allowance for others. If he was perhaps naturally quick in temper, he was never unkind or contemptuous of others, and always placable. . . . His taste in artistic matters was good, and he took an intelligent interest in many things. One more trait, he was exceedingly generous in money matters, almost more than he could afford. Lastly, he was a consistent disciple of Christ, humble-minded and pure in heart, and he was a sincere member of the English Church."

E. M. LLOYD.

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REVIEWS.

AIRCRAFT IN WARFARE.

The Dawn of the Fourth Arm.

By F. W. Lanchester, M.Inst.C.E., M.Inst.A.E. (With an Introductory Preface by Major-General Sir David Henderson, K.C.B., Director-General of Military Aeronautics.—Constable & Co., Ltd. 12s. 6d.).

The greater part of this work was written during the closing months of 1914; and such has been the progress made in military aviation during the past year that the work, in so far as it relates to aircraft in warfare, seems a trifle out of date.

Mr. Lanchester commences by considering the air service as a fourth arm, and expresses the opinion that (at the time of writing) the machines were numerically so weak that, as an arm of the Service, the aeronautical services were a negligible factor. It being an admitted fact that the machines were too few, though perhaps to say that the flying arm was negligible was rather overstating the case, it is a pity that Mr. Lanchester should have chosen to institute a numerical comparison with the cavalry; for by so doing he puts forward a very false argument, tending to defeat his own end.

He suggests that a suitable basis of comparison will be to compare the aeroplane with a single trooper; admitting that the capital cost of the one is far greater than the other he is still of the opinion that making due allowances for this the value of the comparison is unaltered. He gives figures to prove his argument. At the outbreak of hostilities, he says, the Germans are reputed to have possessed some 500 aeroplanes. Would the German cavalry have proved of any real utility, he asks, had they been limited to this number? Answer is unnecessary. Now if his basis of comparison is correct it follows of necessity that 500 aeroplanes would prove useless. But he draws attention to the effective reconnaissance of the German aeroplanes, proving himself that this number of aeroplanes proved of very real utility.

It would seem impossible to institute a comparison on a numerical basis between cavalry and aircraft; experience alone can show the requisite strength of the fourth arm compared with other arms. It is doubtful whether the reconnaissance duties of aircraft and cavalry can be fairly compared. Each has its advantages and its limitations. Troops deployed, or taking advantage of natural cover may and have escaped unseen by an aerial observer, while they would be found by cavalry scouts. On the other hand the radius of action of cavalry is small compared with that of an aeroplane; further, an observer in an aeroplane will be able to see movements of large bodies of troops

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behind the cavalry screen through which, for a time at any rate, the opposing cavalry would be unable to penetrate.

Mr. Lanchester considers that the obvious disadvantage of the aeroplane for reconnaissance is that it informs the enemy of the presence or advance of a hostile force. This does not seem to be a great disadvantage, as the presence of hostile cavalry gives the same information to the enemy, and further, owing to the smaller radius of action of cavalry, allows him to make a more accurate guess at the probable distance of that hostile force, even have his scouts, aerial and otherwise, failed to discover its presence. These remarks apply of course to field warfare; this portion of the book was written before trench warfare had commenced. Needless to say, under the present conditions reconnaissance duties—except engineer reconnaissance—devolve entirely upon the fourth arm.

The question of aeroplane *versus* dirigible is next discussed. Mr. Lanchester suggests that 100 yards of barbed wire trailed below an aeroplane would prove an efficient weapon against a non-rigid dirigible or balloon; while ordinary rifle or machine-gun fire is comparatively ineffective. The writer does not know whether the experiment of flying an aeroplane with 100 yards of barbed wire trailing from it has been tried; at first sight it seems that unless the aeroplane had been specially designed always to fly in that condition, the head resistance of the wire might so lower the centre of drift as to seriously affect longitudinal stability. This may not be so; Mr. Lanchester knows all that can be known on the subject of lift and drift. Granted that flight is possible; the effect on the aeroplane of catching a gas bag with barbed wire hard enough to rip it open would very likely be such that ramming tactics might as well have been adopted in the first instance, as more certainly productive of the desired result, and no more dangerous to the pilot. In the event of an aeroplane getting within 300 ft. of a dirigible, and above it, *i.e.* near enough to draw the barbed wire across it, the third method of attack suggested by the author seems the safest and most certain, namely the dropping of heavy objects or bombs—preferably bombs—on to the envelope.

Mr. Lanchester draws the conclusion that the weaknesses of the dirigible on the defensive are so great and of such a character as to render it quite unfit to remain an active participant in aerial warfare. Sixteen months later, however, there is only one authenticated case of an airship being brought down by an aeroplane; the occasion being that on which the late Flight Sub-Lieut. Warneford, flying a Morane monoplane, bombed and destroyed a Zeppelin, thereby winning the Victoria Cross.

The question of the most suitable armament for an aeroplane is discussed at some length. The author is of the opinion that in field warfare considerable damage could be done to the enemy's *personnel* by machine guns; while with sufficient aeroplanes an area extending from 50 to 100 miles behind the enemy's front line might be devasted by bombs, breaking down his lines of communication and supply, and forcing him to retire. This seems an excellent suggestion; but when one considers that in front of our portion of the line alone an area of

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from 1,500 to 3,000 square miles would have to be devasted, the number of machines and bombs required begins to appear somewhat greater than is quite feasible.

Mr. Lanchester expresses the opinion that the aeroplane bomb used as a weapon of offence against *personnel* will not be very useful unless troops can be caught massed; but that the best method of employing it will be to attack depôts, arsenals, etc., with flights of aeroplanes, each dropping several bombs. Since the book was written this has been done several times; it is to be hoped that more military damage has been done in these attacks than the Zeppelins have done in their various visits to this country.

Further questions which are gone into are armour, aerial tactics, attack by and defence from gun fire, naval aircraft, flying grounds, international questions relating to aircraft, air raids, and many other points too numerous to mention here.

As may be seen in the foregoing *résumé* there are, as Major-General Sir David Henderson, K.C.B., says in his preface, many points in the book which are highly controversial. This does not at all detract from but rather enhances the value of the work, as controversy opens new fields of thought and gives rise to new lines of action. At the present time, unfortunately, all matters connected with military aviation cannot be openly discussed, as this would involve the publication of information much of which must not, for obvious reasons, be published; and much of which is still shrouded in the fog of war.

From a military point of view, perhaps the most valuable portion of the work is contained in two chapters which, while applicable to aerial warfare are by no means confined to it, and are referred to by the author as a digression. These chapters contain a theory which Mr. Lanchester terms the N-square law, a mathematical expression of the fundamental principles of concentration; which Major-General Sir David Henderson calls a most valuable contribution to the art of war. The law is perhaps of sufficient interest to warrant its inclusion here.

One of the great questions at the root of all strategy is that of concentration; this is especially the case in modern warfare, in which killing is done at a distance, as this enables the destructive effect of a larger force to be concentrated on the smaller object of a lesser force to a far greater extent than was possible in the days when battles were fought hand to hand with sword and axe. In those days, supposing that battles were fought until the whole of the vanquished force were put out of action, it is reasonable to suppose that if a force of 1,000 men met a force of 500 men, of equal individual fighting value, at the end of the battle 500 men would be left of the greater force, while the smaller force would be wiped out; provided the line of battle remained unbroken. Now, however, the whole 1,000 men would be able to concentrate their fire on the 500, with the result that the rate of losses in the smaller force would be much greater than that in the larger force.

All things being equal except numerical strengths, each man in a given time will score, on an average, the same number of effective hits; that is to say, the losses on one side will be directly proportional to the numerical strength of the opposing force; if the individual fighting

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values (depending on arms, etc.) are unequal, the losses will be modified according to the respective fighting values of the opposing forces.

To put this in mathematical language:—

Let b be the strength of a "Blue" force.

Let r be strength of a "Red" force.

t represents time.

Then
$$\frac{db}{dt} = -r \times c.$$
$$\frac{dr}{dt} = -b \times k.$$

c and k are constants. ($c = k$ if the fighting values of the individual units of the forces are equal).

For the condition of equality—

Let M be the individual value of a unit of the "Blue" force.

" N " " " " " "Red" "

Rate of reduction of "Blue" force—
$$\frac{db}{dt} = -\mathrm{N}r \times \text{constant}.$$
and "Red"
$$\frac{dr}{dt} = -\mathrm{M}b \times \text{constant}.$$

For the condition of equality—
$$\frac{db}{b \times dt} = \frac{dr}{r \times dt}$$
or
$$-\frac{\mathrm{N}r}{b} = -\frac{\mathrm{M}b}{r}$$
or
$$\mathrm{N}r^2 = \mathrm{M}b^2$$

In other words, the fighting strengths of the two forces are equal when the square of the numerical strength multiplied by the fighting value of the individual units are equal.

This is the N-square law. It appears at first sight theoretical; but the author goes on to deduce from it sound conclusions as to the relative value of rifles and machine guns, and shows with considerable exactness the danger of a divided force. He finishes up by applying the law to a concrete example, namely the Battle of Trafalgar, when Nelson, with a numerically inferior force, defeated the combined French and Spanish Fleets. Whether Nelson had actual knowledge of the N-square law or not, it is impossible to say; probably not; but the fact remains that his plan of attack consisted firstly in cutting the enemy's line into two parts whose proportions exactly corresponded, according to the law, to the reduction of his total effective strength to a minimum; and secondly, in dividing his own fleet in the proportion required, according to the N-square law, to give a fighting strength equal to tackling the two halves of the enemy on level terms.

As Mr. Lanchester remarks: "although we may take it to be a case in which the dictates of experience resulted in a disposition now confirmed by theory, the agreement is remarkable."

J.D.B.

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WHAT TO OBSERVE AND HOW TO REPORT IT.

This little book was written many years ago by the late Colonel Sir Lonsdale Hale, R.E., for the use of junior officers and N.C.O.'s of the British Cavalry. The present edition, the eighth, has been revised and brought up to date.

Section 1 explains what reconnaissance is and deals with reports, and general remarks on how to make them.

Section 2 deals with the objects on which reports may be required, and the information to be given with respect to each.

Section 3 is a short section dealing with the manner in which information obtained should be put down on paper.

Section 4 gives simple instructions as to how to make a sketch of the ground reported on, either by enlarging or reducing a map, or without the aid of a map. A simple explanation of contours is also included in this section.

Section 5 contains a few remarks on map reading.

Section 6 gives a list, with reference to reconnaissance, of things which every Cavalry N.C.O. should be able to do fairly, and also the outline of a small scheme explanatory of the kind of road reconnaissance which might have to be carried out on service. At the end of the book are tables of weights and measures, some hints on sketching, and an example of headings for a report; also four plates, two illustrating contours, a road sketch, and a plate of conventional signs.

The book is written throughout in very simple language, and should be useful to junior officers, or N.C.O.'s, desirous of studying the elements of reconnaissance.

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NOTICE OF MAGAZINE.

REVUE MILITAIRE SUISSE.

No. 11.—*November*, 1915.

NOTES AND NEWS.

Portugal.—The Portuguese Government has recently decreed the breaking up of the Portuguese Artillery into two separate branches, namely, into field and garrison artillery. It had been recognized for some time past that, owing to the great complexity in the problems dealt with by the two branches and the great difference in the technical questions affecting them, a change would have to be made. The interests of the old class of officers have, it is said, been suitably protected by the law giving effect to the above reorganization.

A successful mobilization of the Portuguese Army, in the entrenched camp of Lisbon, has been carried out recently. The manœuvres carried out by mixed columns and the range practice of the field and garrison artillery appear to have given complete satisfaction.

INFORMATION.

Obituary notices relating to Colonel Aymon Galiffe and Lieut.-Colonel W. de Rham are published in this number of the *Revue*.

The Army Order published by General Wille recalling Morgarten is reproduced. It was in this field that, six centuries ago (on the 15th November, 1315), the mountaineers of Schwytz, of Uri, and of Unterwald won the right of independence and liberty for the young Confederation to which the Switzerland of to-day owes its origin.

This number concludes with a Bibliography of works of military interest.

No. 12.—*December*, 1915.

THE OPERATIONS OF THE BELGIAN ARMY IN 1914.

It is stated in an Editorial note that the following works have been consulted in connection with the compilation of the article under review, viz. :—

L'Action de l'armée belge pour la défense du pays et le respect de sa neutralité. Rapport du commandement de l'Armée. Paris, Chapelot, 1915.

La Campagne de l'armée belge (31 Juillet, 1914—1er Janvier, 1915). D'après les documents officiels. Paris, Bloud et Gay, 1915.

Les pages de gloire de l'armée belge, par le Commandant Willy Breton. Paris, Berger-Levrault, 1915.

A review of the first mentioned of these works appeared in the number of the *R.E. Journal* for November, 1915. The second of the above-

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mentioned works contains a more detailed account of the operations than that given in the first mentioned; whilst the last-mentioned work deals to a great extent with the episodes connected with the fighting on the Gette and on the Yser.

The writer of the *Revue* article states that, at a time when the word neutrality still had some signification, it was found to be an interesting study to compare the neutrality of Switzerland with that of Belgium and to distinguish, from the point of view of International Law, the points of difference between this state of national existence in these two countries. However, at the present time, when Might is Right, more is to be gained by making a comparison of the armed forces of neutral states rather than their constitutions.

Belgium, as was the case with Switzerland, felt compelled in recent times to adopt measures for augmenting her army, but as events have turned out this step was taken too late, in the case of the former country, to produce the results aimed at. For, whilst the Swiss Army Laws of 1907 and 1911 have already fulfilled their purpose, on the other hand the Belgian Army Law of 1913 had scarcely come into operation when the present war broke out. The Law last mentioned was intended to provide Belgium with an army of 350,000 men, at War Establishment, in 1918.

The organization of the Belgian Army is given in the article under review and a reference is also made to its armament. As these matters are fully dealt with in the review of the Belgian operations which appeared in the number of the *R.E. Journal* for November, 1915, it is not necessary to repeat the information here.

It is pointed out that it was due to lack of heavy artillery which prevented the Belgian Army from deriving full advantage from the partial successes obtained by it on several occasions during the early stages of the War. The operations of the Belgian Army, prior to the period of the present trench warfare, can be divided into five distinct phases, viz.:—

(i.). From 4th to 20th August, 1914: defence of Liège, Namur, and the region between the Meuse and the entrenched camp of Antwerp.

(ii.). From 21st August to 27th September, 1914: offensive strokes by troops based on Antwerp.

(iii.). From 28th September to 6th October, 1914: defence of entrenched camp of Antwerp.

(iv.). From 7th October to 15th October, 1914: evacuation of Antwerp and retreat to the Yser.

(v.). From 16th to 31st October, 1914: Battle of the Yser.

During the first four phases the Belgian Army took care not to enter into a battle likely to involve serious consequences in the event of its defeat. It was able, owing to local successes, to maintain its position on the Gette, but as soon as it was seriously threatened it disengaged itself and retired into Antwerp, with the intention of awaiting developments under the shelter of the works of the great fortress.

In the period covered by the second phase, the confidence of the

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Belgian Army in its ability to hold out under the shelter of the works of Antwerp increased in spite of the fact that no decisive results had been obtained from the strokes delivered from Antwerp, owing partly to the absence of heavy artillery and partly to the relatively small numbers of the Belgian troops. However, as soon as the third phase was entered, the effects produced by the first shells fired into Antwerp by the Germans, on the 28th September, 1914, rapidly dispelled any illusions, as to what was in store, which may have been cherished at the Belgian General Headquarters. The damage done to the first line forts, during the first two days of the German bombardment, left no doubt in the minds of the Belgian General Staff that Antwerp was doomed and that an early capitulation of this fortress could not be avoided. During the fourth phase the early anticipations regarding the value of the defences of Antwerp were completely dissipated. When the fifth phase opened the Belgian Army had already lost one third of the infantry force with which it began the War, although its artillery was still intact. However, although attacked in its positions on the Yser by a German force of far superior numbers, the Belgian Army gallantly barred the German advance on Dunkirk and Calais and maintained a foothold on its native soil. Briefly, in spite of defects in organization and of its want of readiness to undertake active operations, the Belgian Army, without the aid of other troops, succeeded for a period of two months in holding its own in positions which had been reconnoitred in peace time.

The question is asked—Could Switzerland have done as much as Belgium did (from the political point of view) had she received an ultimatum on the 2nd August, 1914, followed by an attack in force on the night of the 3rd—4th August following? Possibly she might have done so, but it is thought that she would have fared no better than did Belgium.

In seeking for lessons to be learnt from the present campaign, the first matter which attracts attention is the rapidity of the Belgian mobilization and concentration; in less than six days the Belgian Army was ready to move with all its transport, although it was taken by surprise whilst undergoing the process of a reorganization. Under the circumstances the results obtained speak volumes for the capacity and training of the Belgian General Staff.

A further question is asked as to whether similar results could have been obtained by the Swiss General Staff? The reply given is as above; it is possible, but in any case the results would scarcely have been better.

Rapid as was the Belgian concentration, nevertheless it was not rapid enough to save Liège. On the contrary, it was Liège which saved the Belgian Army. As Switzerland has no fortress similarly situated to the last named, the concentration of her army would, under identical circumstances, have run the risk, it is thought, of being seriously interfered with by the enemy.

The fall of Namur was a military event possessing characteristics different from that connected with the German capture of Liège; surprise played no part at Namur. The German success at the more southern of the two fortresses is attributed to the superiority in the attack over the defence, owing to the manifest superiority of the heavy

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artillery of the attackers over that possessed by the defenders. Switzerland, it is said, should congratulate herself that she has not been spending her money on fortifications which a possible enemy could destroy in five days. This must not be taken to mean that the Belgian fortresses were altogether useless, although they did not effectually fulfil the purpose for which they were constructed.

When, 50 years or so ago, Brialmont took up the question of fortifying Antwerp, a considerable discussion arose in Switzerland as to the advisability of providing a central réduit or stronghold as a base for the Helvetic Army. At that time, and even at a later date, heated controversies have raged between the partisans of the "système central" and those of the "système périphérique"; the advocates of the "système radial," proposed by Colonel Rothpletz and having for object the establishment of a fortified barrier across Switzerland from Basle to Zurich, also contributed their views on the subject about the same time.

Whether a central stronghold, as a base of manœuvre for the Swiss Army, would be of any real value is a question difficult to decide with the information available at the present time. If the six weeks which elapsed between the 20th August to the 27th September, 1914, represents the time required by the Germans in which to complete their arrangements for the investment of Antwerp, there is certainly some evidence in support of the view that an entrenched camp of this nature may still be made to answer a useful purpose; on the other hand, if the delay referred to was attributable to causes other than those connected with the German preparations for an investment, then the value of such an entrenched camp becomes problematic. Consequently, in the one case it would be a matter of regret to the Swiss military authorities that no central stronghold existed in their country; in the other, the Swiss people may well be satisfied that their money has not been spent on a useless venture.

The best proof of the value of the services rendered to the cause of the Entente Powers by the stand of the Belgian Army on the Yser lies in the fact that the French Headquarters were able to detach but one division, in addition to the Marine Brigade, for the purposes of reinforcing the Belgian Army during the fifteen days of the desperate fighting on the front, from Dixmude to the sea. If the Belgian Army had not held out on the Yser, the Anglo-French left wing would have been enveloped and forced back across the Lys, and probably even across the Somme.

Extracts from the *Pages de Gloire* reproduced in the *Revue* deal with the part played by the Belgian Artillery and field fortifications at the Battle of the Yser. The lesson to be learnt from these extracts is that light field guns can, when properly dug in along a defensive position, hold their own for some time against even heavier guns; but to attain this result a high state of discipline is required on the part of the gunners and involves an enormous expenditure of ammunition.

When the Battle of the Yser was ended 200 out of the 350 guns which had taken part therein were temporarily out of action; and on the 4th November, 1914, when the 2nd Belgian Division made the offensive stroke against Lombaertzyde, only 15 out of its 48 guns were still

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fit for use. On the other hand, the losses in *personnel* in the fight on the Yser do not appear to have been heavy; the thickness of the parapets seem to have played a less important *rôle* in the matter than the courage of the defenders.

A pious hope is expressed that if some day Switzerland is unfortunately drawn into a war fate will deal more kindly with her than it has, up to the present, dealt with Belgium; and further that, in the event of Switzerland being overtaken by such a disaster, her army chiefs will exhibit an energy and aptitude for war equal to that shown by the Belgian chiefs, and that, at the same time, her soldiers will apply the same devotion to their country's cause and the same contempt for death as that shown by the glorious defenders of the battle line on the Yser.

MACHINE GUNS AND INFANTRY.

It is felt to be premature to attempt to draw any general deductions from the events of the present war. Although in some few cases certain facts have been established with some degree of certainty, no definite conclusions can yet be drawn therefrom. Such is the case even in the matter of the *rôle* played by machine guns in the present war, although it exceeds the expectations of those who have been most enthusiastic in pushing this arm to the front.

The belligerents early in the War recognized the importance of machine guns and immediately set to work to increase the numbers of this weapon with their various formations; details relating to these increases are, however, not available. It is known that in France machine-gun companies have been formed—apparently attached to the infantry brigades. The great increase in the number of machine guns in the German Army is made evident by the great numbers known to be in position in the German trenches; they exceed in number the six per regiment existing prior to the War.

Before the present war the machine-gun organization of the Continental Powers was briefly as follows:—

Switzerland: A group of three companies (of four machine guns apiece) per infantry division and a company (of eight machine guns) per cavalry brigade; in addition at least one machine gun per battalion and one such gun per squadron.

Germany: Eleven "Abteilungen" of six machine guns each, attached for training purposes to Jäger battalions, but intended to be employed in connection with operations with the cavalry divisions; one company of six machine guns per infantry regiment and Jäger battalion; also an average of two machine guns per battalion, and one such gun per two cavalry regiments.

France: A section of two machine guns per battalion of infantry and of chasseurs; and two sections of two such guns apiece per cavalry regiment.

Italy: A section of two machine guns per infantry regiment and per battalion of Bergsagleiri; and a section of two machine guns per cavalry regiment.

Austria: A section of two machine guns per "field" infantry regiment and per battalion of Jägers; and a detachment of two sections per "mountain" infantry regiment and per cavalry regiment.

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It is further probable that all the belligerents have modified their machine-gun organization since the commencement of the present war.

The question of increasing the number of machine guns in the Swiss Army has recently been under discussion, but no information on the subject has been made public yet.

The experience of the present war has shown how difficult it is to locate machine guns, when properly screened in defensive positions. For example, during the great offensive of September last in the Champagne, when the German positions were subjected to an intense bombardment for a period of 72 consecutive hours so that it appeared that the German first line trenches were completely destroyed, there still remained a number of German machine guns in well-concealed emplacements. These guns were untouched by the French artillery fire, consequently, when the French infantry advanced to the attack, the leading units came under a severe machine-gun fire and suffered very heavy losses. This apparent invulnerability of machine guns may be explained on the supposition that the long period devoted to the " artillery preparation " in this case gave the Germans an opportunity to concentrate a very large number of machine guns on the front threatened. Being small and easily transportable (on tripod mountings), they can be readily withdrawn from one part of a line and quickly transferred to another. Further, as only two men are required to work such a gun in an emplacement, and one of these is always under cover, the casualties in the machine-gun detachments are relatively small.

Although, at the present time, the fighting has degenerated into trench warfare, yet it must always be borne in mind that ordinary field operations may again be resumed; when this occurs, machine guns mounted on travelling carriages will, it is thought, be found most useful for the purpose of being rapidly pushed forward to localities occupied by an advanced guard in order to be utilized for the purpose of compelling the enemy to deploy at distances of at least 2,500 yards from the points held by these guns; for reinforcing the rifle fire against some decisive point; for holding on to a position to the last moment during a retreat; for harassing a retreating enemy, etc., etc. In the last-mentioned case, machine guns are themselves very liable to be surprised, and, therefore, it is recommended that they should be provided with an escort of cavalry.

The *rôle* assigned to machine guns should be to appear suddenly at the point where a particularly intense fire against an enemy is necessary and to disappear as suddenly before they suffer damage at the hands of hostile artillery or machine guns; they should particularly avoid coming under artillery fire. Normally, machine guns should be held in reserve under the direct orders of the divisional commander, and as soon as the special task assigned them has been completed, they should at once be brought back to the position of the divisional reserve; their ammunition supply should then be immediately replenished so that they may be ready for the next task allotted to them.

It is proposed to attach the new Swiss machine-gun companies to the infantry; it is feared that their means of transport will not enable them to move rapidly. It is intended that they shall accompany their

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regiments, either as a company or broken up into sections, and that they shall take up positions either on the same line as the infantry, or slightly in rear, with the object of giving them material aid and affording moral support. It is expected that the intensity of their fire will compel the enemy to seek cover, and thus provide an opportunity for the infantry, of their own side, to advance by rushes. They will, it is assumed, also be able to bring an oblique fire to bear on hostile troops advancing to the attack as these become exposed to view owing to the irregularities of the terrain. Machine guns are often likely to be attached to an advanced guard but, it is thought, that they should not, as a rule, be employed with troops detailed for outpost duties. Defensive positions will continue to afford the ideal conditions for the most effective employment of machine guns, particularly where the sinuosities of a front enable them to occupy points from which oblique fire can be brought to bear on the enemy's line of advance.

Whether machine guns are employed as independent groups or regimentally, the tactical principles involved in their use are identical; the principle which dominates all others is that there shall be the most intimate co-operation or "liaison" between the machine guns and the other troops with which they are for the time being associated. For some time past considerable importance has been attached to this type of "liaison" and important results have followed in France by the measures adopted to provide for the "liaison" more particularly between the infantry and the artillery. The term "agent de liaison" is now a commonplace term in the mouths of even the civil population. Much attention has been devoted to this subject in Switzerland in recent times, and although sufficiently satisfactory results have been obtained in the vertical scale of the hierarchical ladder, yet the aspect of the question which affects the "*liaison horizontal*," *i.e.*, between commands of same relative status, has not received the attention it deserves. In order that the fullest advantage may be secured from the fire effect of machine guns in assisting the advance of infantry it is desirable that some simple code of signals should be prearranged, in order to provide for a rapid intercommunication of information and orders between the machine-gun detachments and those with whom they are co-operating.

Two important paragraphs from the *Swiss Training Manual for Machine-Gun Detachments* are reproduced in the *Revue*; it is recommended that these paragraphs should also be inserted in the *Swiss Training Manual for Infantry*. They read as follows:—

"315. All demands for ammunition should be addressed to the nearest infantry troops in the fighting line; the latter must, immediately on receipt of such a demand, hand over complete ammunition carts, with the ammunition they contain, to machine-gun units; only thus can a satisfactory replenishment of ammunition be provided for.

"319. Troops on whom a demand is made for *personnel* for the machine-gun service must immediately meet such a demand."

It is considered to be regrettable that rules of such deep significance should only be known to those who are aware of their supreme importance, but unknown to the majority of those who may be required to give effect to them.

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Trenches, Obstacles, and their Defenders.

Some Impressions from the French Front.

The article on the above subject in the *Revue* is illustrated with photographs taken at the Front. It is pointed out therein that it is but two years ago that the General Staffs of the European Armies issued their latest regulations on field fortification; and at no time have regulations—in this case based on the experience of the Russo-Japanese War—had to meet so completely and promptly the test of actual warfare.

Since the flanks of the belligerent armies in the western theatre have been secured, it is the complete exhaustion of one or the other side, so it is suggested, which can alone disturb the equilibrium that has been established by the occupation of opposing trench lines by the two sides. In this war of attrition and of technical appliances the calculations as to the probable date when exhaustion will occur must be based on statistics, *i.e.*, in relation to factors of importance in the field of political economy.

The characteristics of the present struggle are of a nature to demand a resort to new methods of procedure of a kind not dealt with in books of instruction; for this reason considerable originality in handling matters in connection with improvised fortifications is required in order to meet these new methods of procedure.

Behind the Trenches.—The talk of certain pessimists causes the newcomer in France, so it is said, some measure of vexation. But a journey along the French lines of communication soon leads to a modification of the first impressions, since it is patent that the situation is far from as unsatisfactory as represented by the aforesaid pessimists. Many difficulties have been overcome and matters are now being dealt with in a calm and strenuous manner.

At the centres where parks have been established motor vehicles and guns are seen in abundance, no longer formed up in parallel lines or in a single column but so disposed as to harmonize with the surrounding scenery and hidden away under trees, etc.

Supplies are being conveyed to the Front by railway, motor transport and in barges. The use of motor transport has brought about considerable changes in the supply services. In other directions also draught animals have been replaced by mechanical transport. For instance, machine guns, artillery and searchlights are now mounted on motor vehicles, and a new echelon has been formed of guns and searchlights so mounted for the purpose of dealing with hostile aircraft.

Among other improvements is a considerable acceleration in the railway services provided for military purposes.

The Trenches.—The *rôle* played by the French first and second-line trenches, their profile and the obstacles provided vary according to the tactical situation at the locality concerned and the circumstances under which the trenches, etc., came into existence. The first-line trenches by no means consist of a continuous parapet. Where the opposing sides are at least 500 yards apart *points d'appui* have been constructed at intervals and are connected up by trenches with smaller posts and

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the positions of the sentries. In localities where less than 300 yards separates the two sides the number of the "centres de résistance" are increased and they are connected up to numerous supporting trenches, echeloned back on their flanks; under these circumstances, this line is, so to speak, the first parallel. Saps are thrown forward from these "centres de résistance," and at a distance of some 25 to 15 yards from the enemy's defences, narrow trenches are constructed laterally and are eventually connected up to form a second parallel. The third phase is that where mining replaces sapping, the grenade the rifle, the dagger the bayonet.

The springing of mines and countermines, which is continually in progress, causes mining galleries to fall in, and thus passages are formed connecting up the two fronts; bayonet contests often take place in the passages. In this way was formed the "*labyrinthe.*"

In the most advanced parallels, 8 to 10 yards from the enemy, grenades and ammunition are stored within reach of the men holding the trenches. The men in the forward trenches are keenly alert; the strictest silence is maintained by them, for the smallest noise draws a grenade attack and is the signal to the enemy's listeners to explode their mines.

The French have adopted the narrow deep type of trench, so much in vogue to-day, along their part of their front; the bottoms of these trenches are, as a rule, 6 ft. 6 in. below the surface of the ground and about 18 in. wide; the walls of the trenches are vertical and revetted with brushwood; drains are provided along the bottoms of the trenches; banquets are kept as narrow as possible, being generally less than 9 in. wide. Loopholes of wood have replaced sandbag types of head-cover. No excavations are made under the front parapets; shelters, to contain from 10 to 15 men, are placed on the rearward side of the trenches.

Machine-gun emplacements are sited so as to provide flanking fire along the front of the position and so as to command the obstacles in front of the French positions. They are provided with head-cover, consisting of wood planks and some 30 in. of earth. The "listening posts" near the lines of obstacles are connected by alarum bells with the observation posts in the trenches.

The trace of the trenches is very sinuous. The ordinary traverses are said to be useless, but very numerous splinterproofs have been provided and practically form bulkheads at every 6 to 9 ft. along the trenches.

Everyone at the Front now recognizes that copses and woods form the best screen; not only do they render the manœuvre preceding the battle invisible, but they also mask retreating troops from view. Artillery positions are, whenever possible, selected close along the edges of woods. The salients of woods are, as a rule, transformed into "*centres de résistance*" to be held by a company of infantry; double approaches are provided thereto; one direct, for use at night, and the other defiladed from the enemy's position, for use by day. The line of trenches is placed inside the edge of a wood and provided with casemates, having about 30 in. of earth as cover. Listening posts and observatories in woods are invariably connected to the commander's post and the nearest batteries of artillery by telephone.

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Obstacles.—Obstacles have been very plentifully provided. Three zones have, as a rule, been established; two rows of wire entanglement 12 to 18 yards wide consisting of the ordinary barbed wire type are provided, separated from one another by a line of the more recent type of coiled wire entanglement. Military pits are often combined with the lines of wire entanglement, the whole forming a zone of obstacles which is, at times, at least 100 yards wide. The coiled wire type of entanglement is said to be more easily constructed than the other types; to be less visible; and to be more difficult to surmount unless previously damaged seriously; its destruction is, however, not so easily effected as in the case of the other types of wire entanglement.

During the second phase of the advance, it is no longer possible to construct lines of obstacles on the foregoing scale; it is usual in these cases to put out *chevaux-de-frise* in front of the sapheads. In the third phase countermines are the best means of checking the enemy's offensive.

Under the Trenches.—The enemy's position is in many cases but a few yards from the advanced parallel; owing to the enemy's machine guns the mine is the only means by which further progress forward can be made thence. In order to carry out mine warfare efficiently men are being specially trained for the purpose.

The Defenders of the Trenches.—The men of both the active army and the territorial force created a favourable impression on the writer of the article in the *Revue*. The spirit of loyalty and of altruism, which pervades all ranks of the French Army, exist in an exalted degree. Officers and men, who were spoken to, expressed the most implicit faith in the future, and exhibited the best of humour and good spirits.

Notes and News.

Switzerland.—The extreme left of the Socialist group in Switzerland have delivered a double attack against the military institutions of the Helvetic Republic. Their latest step has been to demand the abolition of Military Courts for the trial of offences against the Military Code; in taking this step they appear to have quite overlooked the fact that as military discipline is something out of the ordinary, therefore, those who are called upon to administer the Code should be drawn from the ranks of those who have made a special study of the subject and have in addition received a suitable training to fit them to undertake the responsibility placed on their shoulders.

The Socialists have further put forward the demand that the pay of officers and men shall be equalized; in this matter also they have missed the mark. If this proposal were carried, the tendency would be to make the career of an officer in the Swiss Army a luxury open only to those belonging to the aristocracy of wealth. This is the last thing that the Socialists—and indeed the whole Swiss people—are anxious to see in their country.

The Swiss General Staff have recently brought out a military history of Switzerland, entitled *Histoire Militaire de la Suisse.* The work consists of twelve parts and is published in German, French and Italian; some of the most distinguished historians in Switzerland have collaborated in its production. The work covers the three great periods in

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Swiss history, namely, 1315 to 1515, Morgarten to Marignan; 1515 to 1815, the Perpetual Peace with France to the fall of Napoleon; 1815 to 1915, the Last Hundred Years. This work is likely to prove extremely popular in Switzerland.

The editors of the *Revue* draw attention to the difficulties they have been experiencing in connection with the production of their publication by reason of the prolongation of the European War; they, however, hope to extend the usefulness of their journal as soon as circumstances permit. Among other things, the Editors hope, at an early date, to devote more space in the *Revue* to matters connected with foreign countries.

United States of America.—Reference is made to the project which is being discussed in the United States of converting the National Guard or Militia, now controlled by the several states, into a central reserve under the style and title of the *United States Reserve.* The project has not yet been laid before Congress; it is anticipated that it will be vigorously opposed by certain States as being subversive of the responsibilities assigned them under the Constitution.

The project in question provides for a regular army of 125,000 men recruited by voluntary enlistment for two years Colour Service; at the expiration of which time the men so recruited are to pass into a reserve for a further period of eight years. If the project becomes law, the United States of America will, eight years from the passing of the law, have a second line of 425,000 reservists.

It is proposed that the 3,000 officers required shall be obtained by offering 12,000 scholarships, each tenable for four years, at the principal American universities. Senator Dick, the promoter of the Militia Law bearing his name, desires to see the United States in possession of a regular army of 250,000 men and the strength of the National Guard raised from 125,000 men to one million.

Congress passed a Bill in October, 1914, which was framed with the object of encouraging rifle practice in the United States; but it would appear that, in spite of this, more than 80 per cent. of the civilians, between 18 and 25 years of age, who are members of the National Rifle Association have never handled a rifle. However, there are indications that the general public in the United States are beginning to take a closer interest in questions affecting national defence. Some of the important trading corporations have recently made it known that they will do all in their power to enable their employés, who belong to the Militia, to attend drills and military exercises; they also undertake to pay full salaries and wages to their employés during the period that they may be engaged in military duties. One Boston house has even gone so far as to offer double pay, during the period of military training, to such of their clerks who may be serving in the Militia. The Association of American Bankers has also passed a resolution to afford financial aid to the Federal Governments and the various States for the purposes of national defence. The most significant step which has been taken in the United States is that connected with the *Business Men's Camps* formed recently at various centres. Merchants, bankers, stockbrokers, lawyers, etc., of all ages have congregated at these camps—the most

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important of which was located at Plattsburg, in New York State—for a period of from 10 to 12 days in order to receive instruction in military subjects from officers of the regular army. The *Business Men's Camps* appear to be looked upon with disfavour by the members of the Militia; probably, it is said, because the public and the Federal Government have shown a decided disposition to support the movement. These camps have also won the support of the *National Security League*, a powerful association, which is already firmly established in some 40 American cities.

The business men of New York, on their return from Plattsburg, decided to retain their regimental organization under the title of the "*Business Men's Training Regiment.*" The Militia, properly so-called, also shows signs of having taken on a new lease of life. In many directions much is being done to improve the training of this force. Recently a Bill was passed in the State of New York for the formation of a reserve to the National Guard, into which officers, N.C.O.'s and men of the Militia could pass on release from the Militia.

This number of the *Revue* concludes with a Bibliography of literature of military interest.

A number of sketch maps relating to the Austro-Italian and Russo-German theatres of operations have also been issued with this number of the *Revue*.

No. 1.—*January*, 1916.

A Talk on Aeronautics.

It is pointed out in the *Revue* article that the present war has shown how very considerable has been the progress in the science and art of aeronautics during recent years. Those who desire more detailed information on the subject than that contained in the article under review can, it is stated, with advantage consult the following publications:—

L'emploi des dirigeables et des aéroplanes à la guerre et le combat contre ces engins. By Major Gœbel, 1910.

L'aviation. By M. Reymond, 1st Lieut., Engineers, 1911.

L'aviation militaire. By Lieut.-Colonel Borel, 1912.

L'aviation à l'exposition aéronautique de Berlin en 1912. By General Hartmann, 1912.

L'aviation militaire en Suisse. By Lieut.-Colonel Borel, 1913.

Les moteurs d'aviation. By Major C. Le Royer, 1914.

L'aviation militaire. By Lieut.-Colonel Borel, 1914.

The author of the article in the *Revue* confines his attention to those aspects of the subject which deal with matters possessing practical importance from a military point of view, such as observation and detection, means of communication between aircraft and troops, fighting power of aircraft and their capabilities for effecting destruction. The subject is divided into two main heads, namely that relating to captive or stationary aircraft and that relating to free or mobile machines.

Captive and Stationary Machines.—In this category are included captive balloons of the spherical as well as the sausage-shaped types, and

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kites. Aircraft of these types are naturally used for observation, and for communication or signalling purposes only.

A table is provided giving the theoretical range of vision over flat land or an expanse of water from points at various altitudes above the same. This table, reduced into British lineal measure, is given below :—

Altitude above Land or Sea.	Approximate Range of Vision.
16·5 ft.	5 miles
33·0 ft.	7 miles
164·0 ft.	17 miles
328·0 ft.	22·5 miles
1640·0 ft.	50 miles
3280·0 ft.	70 miles

Owing to the atmospheric conditions which prevail at certain seasons of the year, the range of vision from captive balloons, etc., is in practice naturally often much less than stated above.

Captive balloons were used for the purpose of reconnoitring the enemy's positions by Custine in 1792 at the Siege of Mayence, and by Moreau in 1794 at the Battle of Fleurus. In 1796 Napoleon made use of balloons in Egypt. Difficulties in connection with the manufacture of hydrogen in the field and other causes militated much against the successful use of balloons for military purposes in the early days referred to. Later, the introduction of coal-gas as an illuminant and improvements effected in the manufacture, etc., of balloons removed some of the earlier disadvantages in their use, and balloons were, in consequence, employed with some success during the Italian War, the American Civil War, and in the Crimea, at the Siege of Sebastopol.

Captive balloons of the spherical type have been found to possess certain disadvantages ; for example, it is dangerous, if not impossible, to make ascents in them during periods when strong winds prevail.

Two problems connected with the use of captive balloons have in the past claimed attention, namely, those dealing with—

(i.). The adoption of measures to secure the stability of the passenger car.

(ii.). The adoption of measures to ensure a proper distribution over the whole of the fabric of the balloon of the strain produced by the cable by which the balloon is anchored.

Arrangements for suspending the car have been devised which allow it to hang with its sides vertical and which cause it to return rapidly to this position when swayed out of it by the motion of the balloon.

In order to provide for the proper distribution of the tension in the anchoring cable to the cordage of the balloon it is generally necessary to pay out, at least, 3,000 ft. of this cable.

The greater the velocity of the wind the greater is the tendency for a captive balloon of the spherical type to be blown down towards the earth ; on the other hand, in the case of a captive kite an increase in the velocity of the wind causes it to rise to a greater height above its anchorage, that is to say, the tendencies produced by high winds in the case of these two types of stationary aircraft are contrary to one another.

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Parseval and Siegsfeld, two German engineers, have utilized the property which kites possess of rising with an increase in velocity of the wind in designing the sausage-shaped captive balloons now in use in the German Army. The stability of the last-mentioned type of balloon depends on—

(i.). The rudder which is provided with a valve connected to the gas bag of the balloon.
(ii.). The tail piece, with its funnels.
(iii.). The side wings.

The Chinese are said to have employed kites for military purposes two hundred years before the Christian era; but this field of employment for kites was later completely lost sight of for many centuries. Weight-lifting kites made their first ascent in England in 1804. In 1874, a man-lifting kite, consisting of a series of fan-shaped structures, was experimented with by the British military authorities. Later, much progress was made with this type of machine in England by Cody; it is recorded that a British officer ascended to an altitude of 3,300 ft. in a Cody machine. Some attention has also been devoted to the subject of weight-lifting kites in Russia and in France. Kites have at various times been utilized for elevating antennæ at wireless stations, for carrying photographic apparatus to obtain records of the enemy's positions, and for detecting the presence of submerged submarines.

In varying degree all captive or stationary aircraft possess a value for communication or signalling purposes; optical devices, ordinary telephones and telegraphs, and even wireless telegraphy have been utilized for establishing communication between captive aircraft and the ground.

Free or Mobile Aircraft.—Under this head are included spherical free balloons, dirigibles and aeroplanes. It is stated that the Swiss aviator Audemars succeeded in reaching an altitude exceeding 21,500 ft. in an aeroplane in 1915.

Free balloons were first employed for destructive purposes in war by the Austrians in 1849, when they laid siege toVenice, but without success. In 1870 and 1871, during the Siege of Paris, as is well known, communication between the French capital and the provinces was maintained by free balloons. It was during this siege that the design for a dirigible of the elongated type was worked out. In 1872, an airship of the type just referred to was actually constructed. Its propellers had to be worked by manual power; the labour required to propel this airship was disproportionate to the speed obtained and the construction of this type of aircraft was therefore abandoned for the time being.

It was not till 1884—1885 that the problem of aerial navigation may be said to have been definitely solved; this result was attained largely by the labours of Ch. Renard who carried out successful experiments with the dirigible "la France"; an airship constructed in accordance with his own designs. But at this time sufficiently efficient petrol engines had not yet been designed to meet the requirements of aircraft constructors. It was first in 1907 that 4 and 8-cylinder motors developing 50 h.p., and weighing just under 20 lbs. per h.p. developed, were put

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on the market. The advent of these motors gave Count Zeppelin, Santos Dumont, the Brothers Wright engines which were entirely suitable for their purposes.

According to the *Taschenbuch für Luftflotten* the position as regards military dirigibles was as follows on the 1st January, 1914:—

	Total Capacity of Airships in cubic feet.	No. of Airships.
Austria	530,000	3
England	883,000	7
Russia	2,225,000	13
Italy	2,416,300	11
France	4,118,000	14
Germany	8,797,000	17

It is pointed out in the *Revue* article that the information given concerning Germany's air fleet in the above table is incorrect, being much below its real strength which was probably twice as great as that stated here.

A brief description of the construction of a rigid Zeppelin airship is given in the *Revue* article. One model of this type of ship is provided with three 180-h.p. engines of the Maybach design, capable of 1,200 revolutions per minute; each engine weighs approximately 8¾ cwt.

It is claimed that at its trial trip the Zeppelin L.Z. 24 rose to an altitude of 10,700 ft., and was in the air for 35 hours continuously, making a round trip of 1,055 miles during this period. However, it carried neither guns nor bombs on this journey.

A very brief description is given of the dirigibles which the British are said to be constructing for the purpose of dealing with the Zeppelin menace.

Aeroplanes.—Considerable progress has been made in the design and construction of aeroplanes since the year 1890—1891, when the matter was first seriously taken up. It was in 1904 that the earliest engine suitable for aeroplanes was first constructed.

Military aeroplanes first put in an appearance at the manœuvres held in France and in Germany in the year 1910, and since then every European power has taken up the subject of military aircraft. The radius of action of a military aeroplane is stated to be about 95 miles; the record flight is 628 miles in 13 hours 17½ minutes.

Monoplanes are said to have entirely superseded biplanes in France; on the other hand, the British, Belgians, Austrians and Germans still show a preference for biplanes.

The Russians have constructed the giant type of Sikorsky biplanes, each capable of carrying 14 passengers. Since the beginning of the present war machines of this type have been armed, and they therefore provide a powerful engine for offensive aerial warfare.

In France, the question of dropping projectiles from aircraft on to definite targets has received considerable attention. It is suggested that, in order to counteract the horizontal velocity communicated to projectiles by the forward motion of the aircraft, such projectiles should be fired from tubes, trained in a direction opposite to that in which the aircraft is travelling and with a velocity equal to the forward motion of

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the aircraft. The moment for releasing bombs so as to hit a particular target is, at the present time, largely a question of guess-work.

In a short summary it is pointed out that, although mobile aircraft are generally believed to be superior to captive balloons for observation purposes, yet in practice this is not really the case. The speed at which aircraft fly through the air is a positive disadvantage. Dirigibles have an advantage over aeroplanes in the performance of *observation* duties, but so far as the *detection* of these two types is concerned the opposite is naturally the case.

From the point of view of communicating information, dirigibles and aeroplanes are in as good a position as captive balloons; since all types of aircraft are provided with identical means for providing this service. The power of mobility possessed by the former types, however, makes their use preferable for this service.

Captive balloons cannot naturally be employed for effecting the destruction of enemy works, etc.; so far as mobile aircraft are concerned those with the lowest speed are most suitable for effecting destruction, and those with the highest speed have the greatest fighting power. —(*To be continued*).

The Suez Canal.

In view of the possibility that military operations may take place in the vicinity of the Canal, some particulars of this important engineering enterprise are given in an article prepared for the *Revue*.

The construction of the Canal was commenced on the 25th April, 1859, and the waterway was opened for traffic on the 17th November, 1869.

Particulars relating to the length, depth, width, etc., of the Canal, and the improvements carried out in 1890 to provide facilities for the increased tonnage passing through the Canal are given in detail in the *Revue* article.

Some of the most important improvements effected since the Canal was first opened have had for their object the reduction of the time taken by ships to pass through this waterway; for example, whereas an average of 48 hours 5 minutes was required for the Canal journey in 1870, this time had by 1890 been reduced to 24 hours 6 minutes. Now that ships are allowed to travel at night the average duration of the Canal journey has been further reduced to 16 hours 11 minutes. One of the most important improvements carried out gradually has been the deepening of the Canal. In consequence, since the 1st January, 1915, vessels, having a draught up to 30 ft., have been able to use this waterway, whereas in 1870 no vessel drawing more than 24 ft. 6 in. of water was allowed to enter the Canal.

It is the policy of the Canal Company to anticipate, as far as possible, the future requirements of the shipping interests and with this object in view a definite programme of work for the improvement of the waterway has been drawn up and put into execution. The deepening of the Canal, so as to permit ships having a draught up to 33 ft. to pass through it, is already in hand.

The harbours at Suez and Port Said have also received much attention since the Canal was first opened to traffic; the capacity of the latter has been increased at least fourfold since 1869.

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The Canal Company has in recent years made a beginning with the construction of a large workshop on reclaimed land, on the Asiatic side of the Canal, for the repair, etc., of the dredgers and other appliances required in connection with the maintenance of the waterway. This workshop will be equipped with electrical machinery; an electric power station for the generation of the energy required and for lighting Port Said, etc., is also being provided.

A plan of the Canal route is given in the *Revue* article, as also a sketch map, borrowed from *Le Génie Civil* of 18th December, 1915, showing the railways from Asia Minor leading towards the Canal. A main railway line connects Constantinople *viâ* Aleppo and Damas to Maan—about 65 miles N.E. of Akaba on the Red Sea. The length of this railway, which is of normal gauge except for a section of about 30 miles north of Damas, is about 1,500 miles. At the beginning of the War, two short sections of the railway were incomplete; a tunnel 5,226 yards long had still to be pierced west of Adana, and about 24 miles of track had to be laid across the Taurus, north of Adana. The tunnel has since been completed, but the track across the Taurus is still incomplete. During 1915 sections of narrow gauge tracks were laid from Afouleh to Bires-Seba, situated close to the Egyptian frontier; and thence a strategic railway has been built across the Sinai Peninsula *viâ* El Aoudjé. A branch railway is also in construction between Maan and Akaba.

It is stated that the carrying capacity of the main line from Constantinople to Maan does not permit the transport of more than 5,000 men per diem.

A RETROSPECT.

The Return of a Contingent: Freiburg, 1499.

In this article is described the return to their homes, in the autumn of 1499, of the Freiburg Contingent which had been enlisted under the banner of Maximilian of Austria two years earlier to take part in the expedition against Rome. In the form of a supposititious conversation between a local inhabitant and a British merchant, who, being on a business visit to Freiburg, is assumed thus to have been a spectator of the historical scene described, much information of historical interest is given concerning the nature of the military service existing in that part of the world in the late 15th century and the customs which prevailed in the Swiss Army of those days.—(*To be continued*).

NOTES AND NEWS.

Switzerland.—The unhappy fate of Belgium and of Serbia and the occupation of Greek territory by belligerent armies are causing some anxiety in Switzerland, particularly in regard to what the future may have in store for the Helvetic Republic. It is felt that the time has not yet arrived for the Swiss people to relapse into a state of somnolence and so to speak disarm themselves in a moral sense. It is pointed out that the danger of an invasion of Swiss territory taking place are by no means past and that Switzerland may yet have to undergo experiences in 1916 similar to those which Belgium went through in 1914 and Serbia in 1915. It is urged that Switzerland should remain ready to meet every eventuality; her preparations should be maintained in a high

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state of efficiency, as well in regard to the moral as the material requirements of the situation.

This being the train of thought of the contributor to the *Revue*, he naturally expresses satisfaction at the measures adopted by the Swiss General Staff for the development of the *morale* of the soldier-citizens of the Republic, particularly in view of the neglect alleged to have been shown by the Civil Authorities to strengthen the *morale* of the Swiss citizen-soldiers.

Last winter, the Swiss General Staff organized a series of lectures for the troops and made an appeal to the intellectual classes to assist them in this matter. The appeal met with a hearty response and lectures on a variety of subjects were given to the troops. During the present winter lectures are also being given to the troops, but, instead of leaving the matter entirely in the hands of civilians, it has been arranged that commanding officers of the various units shall themselves deliver a number of lectures to their men. In order to assist the military lecturers pamphlets have been prepared, giving an outline of the subjects concerning which information is likely to be of value to the troops.

Last year the lectures were arranged with the object of preventing the troops, which have been mobilized for the period of the War, falling into a state of lassitude and becoming bored. A very large proportion of the men doing military duty in Switzerland at the present time have not a bellicose temperament; being withdrawn from their businesses and from hearth and home, there was a serious risk of their relapsing into a lethargic condition during the long winter days unless some mental stimulus could be applied to keep them fully interested in the abnormal situation. The object in view in the lectures arranged for the present winter course has been to arouse and develop the patriotism of the troops. These lectures therefore deal largely with Swiss history, its political institutions, etc.

In order to ensure that not only the patriotism of the troops shall be stimulated but also their martial spirit roused, matters connected with the present war are also being dealt with in the present course of lectures as well as the subjects already mentioned.

Portugal.—In a contribution by a special correspondent it is stated that, in commemoration of the centenary of the Peninsular War, a popular history of the great upheaval of the preceding century has recently been published by a committee appointed for the purpose. The work has been written with the object of bringing before the Portuguese people some of the most stirring events in the history of their country, in order to teach them what they have gained from the self-denial and patriotism of their ancestors.

In the Notes, a few of the leading features of the period dealt with in the history in question are mentioned. It is pointed out that the second invasion of Portugal clearly teaches that: "It is impossible to conquer a nation which, like Great Britain, possesses the dominion of the seas. For, without doubt, it was the mastery of the seas which made possible Wellington's surprise disembarkation at Lavos, the rapid change of base to Corunna by Moore, the concentration of a new army at Lisbon for an attack on the French in the north of the Peninsula."

The Peninsular War is the greatest national convulsion of all time

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which has affected Portugal. It is stated that the following lessons can be drawn from the history of this war, namely :—

(1). The great vitality of the Portuguese nation and their attachment to the independence of their country.

(2). The fact that States which neglect their army in peace time are, at critical periods in their history, at the mercy of those who come to their assistance at the hour of need.

(3). The fact that the Portuguese, when well led, make excellent soldiers, capable of acts of the greatest heroism.

A century has gone by since the days of the Peninsular War and Europe is once more a great field of military operations. Portugal herself has entered into alliances and the question is asked whether it can remain outside the present general conflagration? All that can be said in reply is that Portugal will show herself worthy of the noble and heroic traditions handed down by the Portuguese of former generations.

INFORMATION.

The Affair of the Swiss General Staff.—The plenary powers conferred on the military authorities at the beginning of the War, it is said, are casting a dark shadow over Switzerland. Trouble has arisen by reason of the confusion which has been created in the public mind between a state of peace and that of war, between military power and civil power, between sovereignty and neutrality.

The situation created by the arrest of Colonels de Wattenwyl and Egli on a charge of espionage, and the decision to try these officers by court-martial have produced a depressing effect in Switzerland. The present unfortunate situation is attributed to the many errors which the Federal Government is alleged to have committed since the first days of the Swiss mobilization after the outbreak of war.

Among other faults attributed to the Government one of the most serious is said to be that connected with the selection of the officer, appointed Chief of the Staff to the G.O.C. of the Swiss Army in 1914. The previous history of these two officers, it is said, made it morally certain that they were not likely to work with that degree of harmony so necessary in the highest ranks of a military hierarchy. Experience seems unfortunately to have proved the correctness of the views held on this matter by those outside Government circles. There is no intention on the part of the contributor of the article to disparage either of these officers; he states definitely that both officers possess high qualifications, and are entitled to hold the most important posts in the Army. The difficulty in the present situation is due entirely to their incompatibility of temper.

Another matter which is causing anxiety in some quarters of the Republic is the impression that the Swiss General Staff is imbued with the idea that the German Army must eventually be victorious in the present war; and the conviction that the opinion so held is reacting on deliberations of the Federal Council at the present time. The present situation in Switzerland is referred to as one bordering on anarchy and it is urged that steps shall be taken at once to alter this state of things.

W. A. J. O'MEARA.

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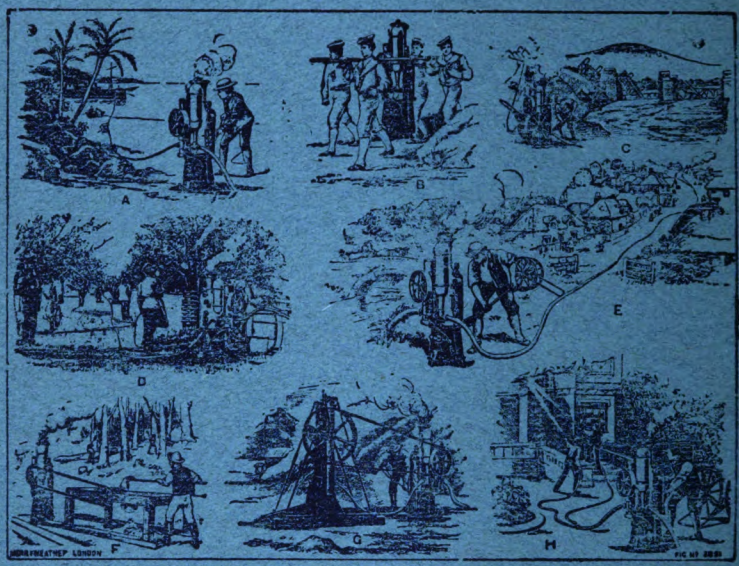

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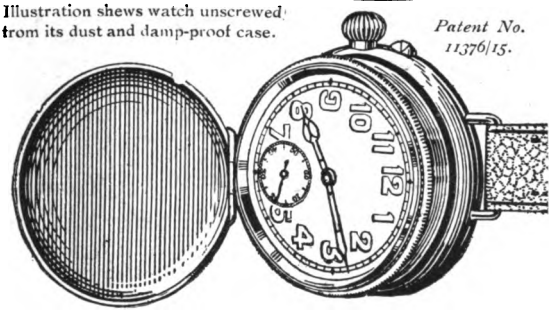

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ERRATA.

R.E. JOURNAL, VOL. XXIII., No. 4, APRIL, 1916.

Line 3, page 155, *for* $({}_3H_5\ (NO_3)_3)$ *read* $(C_3H_5\ (NO_3)_3)$.

Sixth line from bottom of page 156, *for* $(C_6H_2 \cdot OK \cdot (NO_2)_3$ *read* $(C_6H_2 \cdot OK \cdot (NO_2)_3)$.

Line 22, page 157, *for* $(C_6H_2 \cdot CH \cdot {}_3(NO_2)_3)$ *read* $(C_6H_2 \cdot CH_3 \cdot (NO_2)_3)$.

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TENSION JOINTS IN TIMBER.

By LIEUT. J. W. LANDON, *Cambridge O.T.C., attached R.E.*

SEVERAL articles on "Timber Girders for Military Bridges" have recently appeared in the *R.E. Journal.* In these certain assumptions are made in designing the tension joints which do not appear justifiable.

Consider first two tension members joined by means of bolts and a simple cover-plate of timber. Such a joint in its simplest form is as shown in *Fig.* 1.

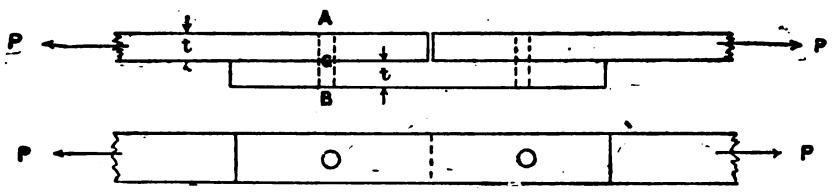

FIG. 1.

Assuming the bolt is kept far enough from the ends of the members, the most probable ways in which the joint will begin to fail are, either by the bending of the bolts, or by the compression of the timber by the bolt.

If the bolts are of sufficiently large diameter so that there is no appreciable deformation due to bending, the distribution of bearing pressure on the bolt will be as shown in *Fig.* 2, where AGB represents the bolt and the bearing pressures along it are represented by the distance from AB to lines CD and EF. This assumes the timber to be elastic and the bolt to remain straight.

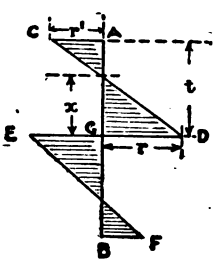

FIG. 2

Neglecting friction between the members, a consideration of the equilibrium of the bolt leads to

$$\frac{rdx}{2}-\frac{r^1d\,(t-x)}{2}=P,$$

where d is the diameter of the bolt.

Also we have $$\frac{r}{x}=\frac{r^1}{t-x}.$$

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From these two conditions—

$$\frac{rdt}{P}=\frac{2x}{2x-t}$$

$$\frac{\text{Maximum bearing pressure}}{\text{Mean bearing pressure}}=\frac{2x}{2x-t}.$$

To find x we have, from symmetry, the further condition that the bending moment at the middle of the bolt equals zero.

$$\therefore \qquad (t-x)\,r^1\{x+\tfrac{2}{3}(t-x)\}-\frac{rx^2}{3}=0.$$

Substituting for r^1 in terms of r we get finally

$$x=\tfrac{2}{3}t.$$

$$\therefore \qquad \frac{\text{Maximum bearing pressure}}{\text{Mean bearing pressure}}=4.$$

Taking the value of $x=\frac{2}{3}t$, it is easy to show that the maximum bending moment on the bolt occurs at a distance from the middle equal to $\frac{t}{3}$.

The maximum bending moment

$$=\tfrac{1}{27}rdt^2 \text{ or } \tfrac{4}{27}Pt.$$

Tests of joints constructed as shown in *Fig.* 1 which have recently been made prove that it is not safe to assume a uniform bearing pressure in designing such joints, and also show that the ratio of maximum pressure to mean pressure is substantially 4.

In the joint considered the bolt has been assumed without a head or nut, and friction between the timber and bolt and also between the two timber members has been neglected. Friction plays a very small part in such joints, and failure occurs by the bolt crushing the timber and finally drawing out of one or other of the members. If the members are bound together friction will play an important part, and the final strength of the joint will be determined by the strength of the binding used. This is due to the fact that the more the joint yields the greater will be the pressure between the two members produced by the binding. This action, it may be noted, will come in whatever the shrinkage of the timber due to climatic changes. The same applies also to a single cover-plate joint in which ordinary bolts are used, so long as a large washer is placed both under the head and nut to prevent them pressing into the timber.

In the case of a joint with a cover-plate on either side, assuming the bolts are of a sufficiently large diameter to prevent any appreciable bending, the bearing pressure of the bolt against the timber may be assumed uniform, but friction will not automatically come into play. Any shrinkage of the timber due to climatic changes after the nuts have been tightened up will reduce the pressure, and this pressure will not be increased by the yielding of the joint.

Another point which requires consideration is the safe bearing pressure of round bolts on timber. It appears that this generally is

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based upon the safe compressive stress of timber parallel to the grain. This is not justifiable, since the safe compressive stress is quite different along the grain from what it is across the grain, the former being some three or four times the latter. In the case of a round bolt fitting in a circular hole both these stresses are introduced, since the bolt wedges in its hole, no matter what is the direction of the pressure between the bolt and the timber. The problem is further complicated by the accuracy of fit of the bolt in the hole. The only satisfactory solution is by experiment.

Below are the results of some experiments made recently at the S.M.E., Chatham, and at Cambridge.

TESTS A.—Timber—Yellow deal.

Bolts—$\frac{3}{4}$-in. diam.

Bearing pressure uniform along the bolt.

Bolt holes bored with an auger.

	Bearing pressure at which the strain ceased to be proportional to the stress.
Parallel to grain	2590 lbs. per sq. in.
	2100 ,, ,,
Perpendicular to grain	1440 ,, ,,
	1190 ,, ,,

In the tests parallel to the grain complete failure of the timber by crushing occurred at a stress only slightly in excess of that given above.

TEST B.—*Made in a Testing Machine.*—Timber—Yellow deal—very well seasoned—different from that used in Tests A.

Bolts—$\frac{3}{4}$-in. diam.

Bolts carefully fitted in holes.

	Bearing pressure at which the strain ceased to be proportional to the stress.
Parallel to grain	3740 lbs. per sq. in.
	3850 ,, ,,
Perpendicular to grain	1400 ,, ,,
	1660 ,, ,,

These results show how variable the safe bearing pressure for bolts on timber is, and more tests are required.

TESTS C.—Single cover-plate joints as shown in *Fig.* 1.

The same timber as in Tests A.

Maximum bearing pressure taken four times the mean bearing pressure.

Diameter of bolt.	Maximum bearing pressure at which the strain ceased to be proportional to stress.
$\frac{5}{8}$ in.	2630 lbs. per sq. in.
$\frac{3}{4}$ in.	2160 ,, ,,
$\frac{7}{8}$ in.	2390 ,, ,,
1 in.	2840 ,, ,,
$1\frac{1}{4}$ in.	2510 ,, ,,

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In these tests the joints finally failed by the drawing of the bolt out of one member, at a load varying from one and a half to twice the load giving the above pressures.

TESTS D.—*Nailed Joints.*—The object of these tests was to determine the lateral resistance of wire nails when used to connect two tension members of timber, the direction of the pull being along the grain.

Most of the joints used were similar to that shown in *Fig.* 1, but with two cover-plates, each one-half the thickness of the members joined, and with wire nails in place of bolts.

The timber was well-seasoned yellow deal, similar to that used in Tests B. The nails were grooved iron wire. The results show that the relation between the lateral resistance at collapse of the joint and the length of the nail, for lengths varying from 3 in. to 6 in., may be fairly well represented by—

Lateral resistance per nail (double cover-plate) = 260 L lbs.,

where L is the length of the nail in inches.

In experiments made with joints having only one cover-plate of thickness not greater than half the length of the nail, it was found the lateral resistance was about half that given above.

A few tests were made with round iron wire nails and these gave substantially the same results as with grooved iron wire nails.

In all cases final failure of the joint was produced by the drawing out of the point of the nail.

It is interesting to compare these results with those given in *M.E.*, Part IIIA., pp. 83—85. Taking the tests in which two timber uprights were connected by a single crosspiece, and where the whole of the nail was in the timber, the results for nails varying from 3 in. to 6 in. in length will be found to be fairly well represented by—

Lateral resistance per nail = 150 L lbs.

In these tests the point of the nail was in the upright members and the pull was parallel to the grain of these members.

Other tests of two members nailed together at right angles, but with the direction of pull perpendicular to the grain of the member containing the point of the nail, might be interesting. It is hoped to make these tests shortly.

Tests are being made at present on the lateral resistance of coach screws when used for connecting tension members.

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SCIENCE AND WAR.

By ANAGAPA.

To deal fully with the part science plays in a modern war is a task, as will readily be realized, beyond the capacity of any single individual: justice can alone be done to the subject by the joint efforts of experts in the many branches of science laid under contribution, directly or indirectly, for the purposes of the prosecution of a war under modern conditions. An adequate treatment of the subject would require, not only a comprehensive examination into the many details of the naval and military services, but also into numerous questions connected with civil administration. A discussion of the part played by science in connection with the affairs of a navy, or an army, alone would occupy in itself the pages of a considerable volume, for there is scarcely a single branch of science, whether it be in the class labelled abstract, abstract concrete, or concrete, by Herbert Spencer, which does not in some way affect the well-being of sailors and soldiers, and the operations of war as conducted by modern navies and armies. At least as great would be the task of dealing comprehensively with the part played by science in matters connected with the civil administrations of a State, since under the conditions of modern civilization no branch of science is left entirely untouched by it. Although it may not be possible satisfactorily to cover, within a reasonable compass, the whole field in which science plays, or is capable of playing a part in modern war, yet a general survey of some of those aspects of the subject in which science plays, or may, at least, reasonably be expected to play a somewhat conspicuous part, does not naturally present the same formidable difficulties. This being the case, an attempt will here be made to review briefly the influence which science and the methods of science exercise, or may be expected so to do, on some of the more important matters connected with the conduct of a great war.

It is well recognized that the principles which govern the prosecution of war in the actual theatre of operations involve considerations widely different from those which affect the more purely civil interests of belligerent nations in the regions more remote from the points of contact of the hostile naval and military forces; yet, in a great national war, no part of the community, and no part of the several interests of a belligerent nation can remain entirely outside the influence of the exceptional situation created by the outbreak of hostilities. This being so, the question has recently come much into prominence, in some countries, whether indeed the time has not arrived for Governments, in cases where the matter has not already received attention, to adopt an organization for war in which the

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boundaries of the responsibilities devolving on the supreme naval and military commanders, and the ministers concerned with the civil administrations of the State, shall be clearly and definitely delineated on the lines of the functions which, in strictness, appertain to each of these two main groups concerned with the conduct of war. Such a separation of responsibilities would, it is claimed, be logical and therefore scientific, and the advantage would be gained thereby that the responsible officers in each of these groups would then be able to confine their attention exclusively to the problems which, by past training and experience, they are best fitted to deal with. To put the matter precisely, the real question raised has been whether the ministers responsible in normal circumstances for the civil administration of a State should, under the special conditions of a great war, also occupy themselves with the formulation and supervision of the naval and military plans of campaign, or leave this aspect in the conduct of a war to be dealt with exclusively by the supreme naval and military commanders.

The conclusion arrived at is that a Central Government, having determined the political object of a war, should do no more than formulate the political and social considerations which must be borne in mind in the prosecution of the war. The objective having been once clearly pointed out, the naval and military methods to be adopted to attain the end in view should, it is urged, be left entirely and exclusively in the hands of the supreme naval and military commanders, so long as their plans conform to the general requirements laid down by the Central Government. This done, one obligation would still remain to be fulfilled by the civil authorities, that of providing the wherewithal in men and treasure necessary for the purpose of waging war. It is argued that, once the division of responsibilities between the civil and the naval and military authorities has been established on a scientific basis, and a complete understanding arrived at between them, the execution of naval and military plans would proceed automatically, and thus produce the highest measure of success attainable with the means and resources of a nation available for the prosecution of the war. Under these circumstances ministers, relieved of all responsibility for the purely naval and military aspects of the plan or plans of campaign affecting the whole theatre of war, would be in a position to devote themselves with greater assiduity to the problems of civil administration arising out of the war, and to the task of organizing the whole of the resources of the nation for the prosecution of the war, if need be. The problems of organization have now been reduced to a science governed by certain well-defined principles; therefore, it alone remains, when any exceptional situation involving the necessity of a change in the organization of a State arises, for a Government to apply these principles for the purpose of determining the nature of the modifications which shall be introduced into its normal organi-

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zation. War creates such a situation, and often demands the introduction of radical changes in peace systems of State administration, and unless methods of science prevail in handling the situation, and particularly so in those regions where the supreme control resides, a nation cannot hope to wage war successfully.

In the face of the profound silence which reigns in relation to the present war, no exact information is available as to the war organizations adopted by the various belligerent nations. One at least of the belligerent nations, Germany, is known to have given considerable study to the science of war, and it is hardly possible that, her motto being "Thorough," the question of the adoption of a special war organization in place of her peace system of administration, can have been overlooked: indeed, there are indications that considerable modifications have been made in the latter. The nature of some of the changes made may be gathered from an interesting description of the working of the "German Machine," during the days preceding the German retreat from the Marne, which appeared in the *New York Nation* of 24th September, 1914. In the article in question it is stated that, within the space of seven days, the German Great General Staff set in motion some four millions of men, and a nation at peace with the world became a nation at war; the components of the German military machine moved, it is said, with the smoothness of an accurately balanced engine and the regularity of a highly finished timepiece.

Simultaneously with the outbreak of war, hundreds of workshops ceased producing articles normally required for civilian consumption, and these hives of industry were at once placed under the orders of the Great General Staff, and, without loss of time, the energies of the workers, not absorbed into the ranks of the field armies, were diverted to the manufacture of uniforms, boots, and other munitions of war required by the troops sent to the front. Since the day that the Great General Staff set the German Army in motion in August, 1914, down to the present day, it has exercised sole and exclusive responsibility in relation to all military measures connected with the prosecution of the present war. At the same time, if reports published in the foreign Press can be relied upon, it would appear that those who have been made responsible for questions of civil administration in Germany, have been by no means backward in attending to the many old and new problems falling within the limits of their responsibilities; they have, from an early date in the war, fully realized that the real peril which threatens the Central Powers is that connected with the economic and financial pressure to which war subjects them. In consequence, a whole army of scientific men have, so it is said, been set to work to make an exhaustive examination into the economic and financial problems produced by the war with a view to the adoption of measures for warding off the dangers and crises, which have been menacing the chances of success for the Central Powers.

The more closely the situation is examined, the more evident it is that

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the German arms have gained by the clear and sound conceptions entertained by the Imperial Government regarding the proper distribution of responsibilities between the civil and military authorities for the purposes of the prosecution of a great war, and by the adoption of a scientific organization to attain the end in view. Without in any way disparaging the organizations adopted, at the present time, in other belligerent States, an admission can safely be made that the application by the Imperial Government of methods of science in the organization of the German Empire for the conduct and prosecution of war affords useful lessons to all who may wish to learn from and profit by the experience gained by our enemies. The subject is an engrossing one, but the limitations of space forbid it to be further pursued here.

It is now proposed to say a few words on those aspects of war which more intimately concern the fighting services themselves. Since the days of almost hoary antiquity, when, by its aid, warships were first navigated across open expanses of water out of sight of land, and the invention of gunpowder provided a new weapon for the prosecution of a war, science has been acquiring a greater and greater influence in most matters affecting the sailor and the soldier. Whether it is the Navy or the Army which owes the greater debt to the advances due to scientific research is a matter in regard to which it is practically impossible for anyone to express a definite opinion: in some directions science has done each of them an identical service; in other directions, it is sometimes the Navy, sometimes the Army which may be considered to have gained most by the more recent discoveries in one or other of the various fields of science.

In outline, the two main considerations affecting navies and armies have remained unaltered from time immemorial; navies and armies have, at all times, had to subsist in the theatre of operations, they have always been expected to fight at an advantage. But in both these respects, as time has progressed, enormous changes have come about in details; science and scientific methods have penetrated more and more deeply, as well in relation to matters connected with the provision of subsistence for navies and armies as in relation to those problems which concern their efficiency to undertake naval and military operations. The science of the chemist, that of the metallurgist, and that of the mechanical engineer have probably had a more marked influence in bringing about changes and modifications in the methods of war than have the discoveries of the workers in any other field of activity.

To the labours of the chemist, the metallurgist and the mechanical engineer, navies and armies owe many of the most important improvements in the armament and propellants, equipment and means of transport, tools and appliances with which they go forth to fight at the present day. Also, to the discoveries made in the field of science with which they are associated is it due that the newest arm, the Flying Corps, has so rapidly reached the high state of development and efficiency which has enabled it, in the present war, to play, both

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in the Navy and the Army, the conspicuous *rôle* so familiar to the public, and that, in spite of its infant years.

During the past half century, another feature which has wrought very great changes in war is the enormous growth in the world's armies and navies; in consequence, theatres of operations cover to-day infinitely greater spaces than of yore. To fight at an advantage, the concentration of superior forces at the decisive point at the appropriate moment is still required to-day as of old: it is the factor still constituting the element essential for the attainment of victory. Thanks to the physicist and the electric engineer, the difficulties connected with the provision of intercommunication between the several components of the vast navies and armies operating in widely separated areas have been satisfactorily overcome: each of these services has to-day at its disposal suitable means for rapid communication, which enable their leaders effectively to bring about those combinations which provide for the simultaneity of action of the several parts of a fighting force, which alone can bring success in modern war. The very considerable assistance the belligerent navies may have derived from wireless telegraphy, and the important *rôle* telegraphy and telephony have played in the land operations, now in progress, can only be fully learnt when the time arrives for making public the experiences of those who have had to provide and maintain these indispensable auxiliaries.

Even a cursory examination of the part science plays in war would be incomplete without reference to all that navies and armies owe to the science of the pathologist and of the surgeon. It is well known that in the wars of former ages disease claimed many more victims than rifle bullets and artillery projectiles; one of the most marked features of most modern wars has been the almost complete immunity which the present-day sailors and soldiers enjoy from the many scourges which ravaged the ranks of their predecessors in arms, an immunity which is alone attributable to the advances made in the science of preventive medicine. Similarly, "Listerism" and many other applications of science, such as Röntgen rays, magnetic extractors, etc., have come to the aid of the surgeon and assist him to alleviate the sufferings, and even to save the limbs, of those mutilated on the field of honour. Let it not be thought that because no express mention is made here of the part played in war by many another branch of science, therefore the aid derived from them by navies and armies is either insignificant or not properly appreciated; neither view represents the truth; few there can be who, having read of aerial reconnaissances and gas attacks, can have allowed their imaginations to go so far astray as to overlook, for instance, the part which the sciences of the photographer and of the meteorologist must play in a modern war.

At the present day is seen the spectacle of a great conflict which is being carried out over a great expanse of the globe, and in which

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naval and military operations are being conducted, not only on the sea, and on and under the land, methods with which our ancestors of a couple of centuries ago were familiar, but to these long-known methods have been added others involving operations under the surface of the water, as well as those high in the heavens above land and water. As remarkable as are the changes in the methods of fighting which have taken place, and to which allusion has been made, is the complete transformation in the character of the weapons used, and in the composition of the forces which now take the field, as compared to those of even a century ago: the ships of modern fleets bristle with technical appliances; in the composition of the higher formations of armies, the relative numbers composing the technical arms show a prodigious increase, not only so, but even the services provided by these technical arms are more numerous and present features of greater complexity. The extent to which appliances of a technical nature find a place in the equipments of navies and armies is after all the best measure of the part science plays in war; these afford evidence on this point which can be almost as fully appreciated by a layman as by a scientific expert.

In taking advantage of the aid which science places at their disposal, navies and armies are but acting on the precepts of the ancients who, by the allegories contained in their mythology, have handed down to succeeding generations the wisdom of their own age. That the ancients appreciated the importance of preparing for war and of utilizing all the aids of science in its prosecution may, in some measure, be gathered from the descriptions of the preparations made by Perseus when he was sent forth to destroy Medusa—even the modern trench-fighter's periscope had a counterpart in the mirror of which Pallas made him gift. Bacon reminds us that: "The furnishing of Perseus with necessaries was that which only advanced his attempt and drew fortune to be of his side." To-day war has a science of its own, and however great may be the debt of gratitude which navies and armies owe to the workers in many other fields of science, to none is their debt greater than to those members of their own great professions who have had the foresight to recognize that it is the furnishing of navies and armies with the fruits of the latest discoveries in the fields of science which only advance their attempts and draw fortune to be of their side, and who have, in consequence, devoted their labours, long and persuasively, to ensure that nothing essential for the conduct of war should be lacking in the equipments of the respective services which have claimed their affections. By kindling one light at another these great men have made provision for the communication of science to the succeeding ages.

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PASSING THOUGHTS ON MILITARY ARCHITECTURE IN THE THAMES DEFENCES.

By MAJOR A. A. CROOKSHANK, R.E.

ANYONE taking a thought on the history of England and at the same time taking up a map of the country, would expect to find evidence of ancient fortifications on the line of approach by water to the capital. He would expect to find examples of military architecture in those places where the defences of the port of London against an attack by sea must obviously be placed, and, it may be added, he would not be disappointed. Architecture may be said to consist of two classes, the "Visible" and the "Invisible." The "Visible," like the poor, we have still with us; the "Invisible" exists chiefly in the pages of history, and in descriptions and drawings. The Thames defences are rich in examples of both classes, indeed, they are a regular museum of military or fortification architecture from 1402 onwards; and, if we include the Medway defences as well, the pedigree can be traced back to the Conquest.

The line of least resistance takes us to the "Visible" of the above two classes; the "Visible" makes a more direct appeal, as anyone can see the building for himself, and "seeing is believing." Seeing is a one-process system, whereas the appreciation of the "Invisible" building involves the use of several processes, such as reading, thinking, and imagining, and even then the result may be disappointing, as there may be a feeling of doubt left in the mind. Statements in history are sometimes founded on very slender evidence, and strike one as, what they call in journalism "unconvincing narratives."

The Thames Defences have visible examples of five different periods in military architecture. Firstly, the 1680, or Jacobean period (the Brick and Stone Age); and secondly, the 1715, or early Georgian period (the Brick Age), both in Tilbury Fort. Thirdly, the 1780 or late Georgian or Napoleonic period (the Earth Age), in New Tavern Fort. Fourthly, the 1870, or mid-Victorian or Crimean period in the "Thames" Forts, Coalhouse, Shornemead, and Cliffe (the Stone Age). Fifthly, and lastly, the more modern or late Victorian period in Hope Battery (the Iron Age).

The first thing one notices in reviewing these five periods, is the rapid decline in military architecture, from the aesthetic point of

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view. *Facilis descensus Averni.* It would not require a very long acquaintance with the iron box of Hope Battery to make one describe it as both a literal and an æsthetic Avernus. How the first period does put the others to shame, especially the last three! How the glory has departed from Israel in the 200 years that elapsed between 1684 and 1884! In the days of the Restoration, England built military buildings that she was not ashamed of, and that she can point to with pride 240 years afterwards. The beautiful carved stone "water gate" of Tilbury Fort is justly celebrated far and wide.

> "Gates of monarchs
> Are arched so high that giants may get through."

Every year people, and the right class of people, too, namely, experts in architecture, building, and in art, travel long distances to see it.

> "The hasty multitude
> Admiring entered and the work some praise,
> And some the architect."

The inscription over the entrance is interesting; it states that the gate was built in the 34th year of the reign of Charles II. On reading this the intelligent and cultured spectator promptly remarks that the statement is stupid, as there was "no sich thing," Charles II. having only done 25 years, from 1660 to 1685. The solution of the problem is that in those days, when patriotism was booming instead of being a sort of freemasonry as it is now, the years of Charles II.'s reign were reckoned from the last year of Charles I., *i.e.*, 1649.

There is much to admire in the buildings of the Jacobean period in Tilbury Fort. Besides the west gate, there is the stone gateway of the sally port on the north side, although it is only the back entrance, so to speak; the little stone arch on the west arm of the outer moat, although it is only the drain to and from the river; the beautiful claret-coloured brickwork with grey stone groins and string course in the parapet wall of the bastioned trace, the brickwork and steep pitched roofs with tiles in chessboard pattern and with white ridges in the main entrance; the mortuary over the Sally Port, with its pyramidal roof; and the two blocks of barracks on the east and west sides, the brickwork in the east block being almost black.

We leave the beautiful work of the 1680 period behind with regret, and pass on to the next period, the Early Georgian of about 1715, as represented by the Chapel and the magazines. Although the interval of time between the two is only a short one, yet a great change is noticeable. During these 30 odd years, domestic archi-

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tecture in England had passed through the Queen Anne period, and this left its mark on the buildings in Tilbury Fort, which indicate a transition period. The Chapel is very Queen Anne-ish, whereas the magazines are more decorated, although only magazines with their buttresses, panel, and colour-scheme in the brickwork.

The Chapel is a fine example of its style, with its windows of varied design; its heavy cornice, and its roof, which is in the Jacobean manner, except that the tiles are in red and black stripes instead of squares. The Chapel is, in its own way, a beautiful building; it does not make that instantaneous appeal that its luxurious and expensive Jacobean neighbour does; it is a building that grows on one, and there is no better test than this of the classical, or that which is made to endure in anything, whether art, literature, or music. The good Queen Anne is always quoted as the great example of mortality; her building in Tilbury Fort might, on the other hand, be quoted as an example of immortality. Both these Georgian buildings, the Chapel and the magazines, have a two-colour scheme of red and buff in the brickwork, and beautiful hopper heads embossed with "1715, G.R.," and down-pipes of square section, all made of thick lead. The brickwork is in great contrast to that in the Jacobean buildings; in the latter the bricks are of a much deeper red colour, evidently of different composition, and they are laid with wider joints.

Of the other three periods previously mentioned, the 1780 (New Tavern Fort), 1870 (Thames Forts), modern (Hope Battery), the less said the better; indeed, from the point of view of the æsthetic in military architecture there is nothing to be said at all. Presumably, these buildings were not intended to be ornamental; certainly no one could accuse them of being so now. Whether, as a provision of nature, they were useful by way of compensation, that is another story.

> "Our fathers next, in architecture skill'd
> Cities for use, and forts for safety build."

As will be observed in the foregoing, it is suggested that the architecture of the Thames Defences might be divided into two classes—the "Visible" and the "Invisible." The "Visible" class having been discussed, it is now proposed to record some passing thoughts on the "Invisible" class. It was also stated that the Thames Defences were a museum of fortification architecture from 1402 onwards; it would, however, be more correct to fix the dividing line between the "Visible" and the "Invisible" class at 1680 and to state that the latter class contains buildings from 1680 backwards. The earliest recorded fortification, built over one thousand years ago, is so "invisible" that it can neither be seen nor even imagined.

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THE KING ALFRED PERIOD, A.D. 893.

All we know is that in the year of grace 893 a fort is said to have been built by King Alfred at Milton. "In 893 a fleet of 80 sail of Danish ships," says Pocock, "under the command of Hastings, the Dane, sailed up the Thames, and erected a Fort at Milton by Gravesend." This is more than probable when we consider King Alfred's character and accomplishments. He was a great general, he was also "able and brave," says Oman, "and far above all men of his day in his desire for wisdom and learning, and from his earliest years was known as a lover of books and scholars. . . . Seldom if ever, did any king combine so much practical ability in war and Governance with such a keen taste for literature and science."

Alfred may be reckoned the father of the English Navy, he built ships of larger size than any that had yet been seen in Western Europe (the "Super-Dreadnoughts" of the period), and provided that they should be well manned. He encouraged sailors, he was a friend of merchants. We have no space to tell of the many other spheres of Alfred's activity, such as his church-building, his mechanical inventions, and his zeal in almsgiving and missionary work. "He saved England from the Dane, and brought her back to the foremost place among the peoples of Western Europe." Last, but by no means least, "he smote the Danes when they dared to invade his realm in his later years." Let us hope that the fort he is said to have built at Milton in A.D. 893 helped to repel these invasions by the Danes and to protect the river Thames, the town of Gravesend and the Port of London.

It is sad that a man of his many-sided genius and culture, and a king of his ability and efficiency should go down to posterity as the king who was scolded by an old squaw for scalding her scones. Yet he is far better known for this accomplishment than for any of his many others. What is fame?

THE HENRY IV. PERIOD, 1402.

The next Thames Fortifications were built more than 500 years later by Henry IV., in 1402. "On the 3rd July, 1402, he directed Commissioners," says Brabazon, "to see works erected properly by the men of East Tilbury . . . within one month from the date thereof . . . (the works to consist of) a curtain wall of earth with garretts." Evidently these could not have been very elaborate or permanent fortifications if they could be finished off by the men of a small village in one month.

There are no drawings of these defences, but we can imagine what they were like. It is recorded that the "town of East Tilbury was fortified by a wall of earth with garretts," presumably a sort of

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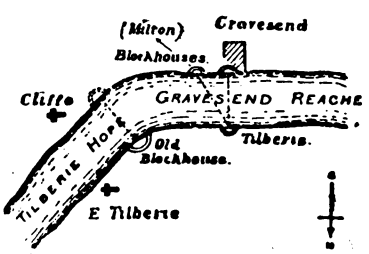
"Roman camp" work or high command earth parapet redoubt with small look-outs or watch towers at intervals round the perimeter. This "wall of earth" was no doubt traced round the high ground near East Tilbury Church and Village, then probably lapped by the salt waters of the Thames or North Sea. These defences were probably built to defend the Port of London against the descents of Norman privateers on our coasts. These raids were encouraged by Lewis of Orleans, the uncle of Queen Isabella, wife of Richard II.

Coalhouse Point was chosen as the site for the defences because it is a strategically strong position, commanding as it does both the Lower Hope and Gravesend Reaches of the river, and also the ferry which then existed across the river at the Point. Similarly King Alfred's fort at Milton guarded the ferry across the river at Gravesend as well as Gravesend town itself.

The Henry VIII. Period, 1539.

Both these schemes of fortification consisted of one fort only. The next Thames Defences were built by Henry VIII., in 1539, or 137 years later. These were of a far more advanced design and covered a large area; they showed great progress in the art of fortification as they were built of masonry and carried cannon. "King Henry VIII. was the first," says Pocock, "who turned his thoughts towards protecting the Metropolis of this Kingdom by the erection of platforms on the sides of the Thames." The defence scheme consisted of five "platforms or bulwarks and blockhouses" (see *Sketch No.* 1). "One," says Brabazon, "was erected at Higham,



Sketch No. 1.

two at Tilbury, and two at Gravesend. They were called Higham, Hermitage (Tilbury or West Tilbury) and East Tilbury, Milton and Gravesend." "He mounted them," says Millar, "with cannon for the defence of the river."

There is no doubt about the sites of the Gravesend, Milton, Tilbury and East Tilbury blockhouses; two of them are shown in a map of the Elizabethan defences in 1588 (see *Sketch No.* 3). "The blockhouses at Gravesend," says Millar, "were both within the parish of

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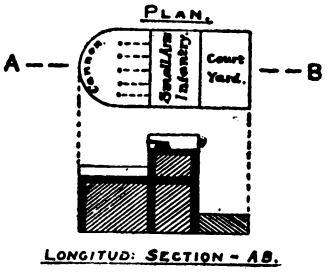
Milton; one was built on the Chapel field near the ancient Chantry, the other in front of the Terrace."

The one at West Tilbury or Tilbury (called "Hermitage") was built on the site of an old chapel. The site of the fifth, the Higham blockhouse, is not known; neither the local nor the county archæologists have as yet succeeded in placing it. My own opinion is that it was on the river bank between the present Shornmead and Cliffe Forts, *i.e.*, on that small and narrow strip of Higham parish which runs down to the river there. The blockhouse was called Higham Blockhouse and was therefore presumably in Higham parish. In this position it would guard the ferry across the river from Coalhouse Point, and also, with its sister blockhouse (East Tilbury) opposite, would block the west end of the Tilbury Hope Reach of the river or the east end of the Gravesend Reach. The approach to the ferry on the Kent side is supposed to have been along an old Roman road leading from Higham, past Higham "Mound" (the origin of which is wrapped in mystery and has never yet been satisfactorily explained) and then across Higham "Common" down to the river. The Romans also are said to have had a ferry at this point.

Henry VIII.'s scheme of Thames Defences against an attack by sea thus consisted in holding two lines across the river, one the East Tilbury to Higham blockhouse line at the inner or west end of Tilbury Hope Reach, or outer or east end of Gravesend Reach; and the other the Tilbury-Gravesend line in the middle of Gravesend Reach. Each of these lines had a blockhouse at each end of it, *i.e.*, the blockhouses were one on each bank of the river and opposite one another. The fifth blockhouse, called Milton, was evidently intended to protect the outlying parts of the town of Gravesend (in Milton parish) from bombardment by the enemy's warships.

As regards the design of the blockhouses themselves, they were of masonry, probably of stone, as better able to stand bombardment by the enemy's naval cannon. They had a semi-circular front (see *Sketch No.* 2); the back part of the blockhouse was at a higher level,



Sketch No. 2.

and from this the small arms were fired; the cannon firing from a semi-circular platform in front of and below the former. At the

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back of the blockhouse was a small rectangular courtyard surrounded by a wall.

Henry VIII.'s fortifications were built to defend London and the shipping of the Port of London against the French Navy. During his reign he was frequently at war with France as his hereditary enemy. In 1513 He landed an Expeditionary Force of 25,000 men at Calais. In 1540 "he had to keep guard," says Oman, "against attacks on the South as well as the North." This would be the period of the Thames Defences. "King Francis had collected a great fleet in Normandy and threatened an invasion of England. Henry was forced to arm." In 1545 the French attacked the Isle of Wight. In 1544 Henry captured Boulogne and retained it against all attempts until 1546, when it was ceded to him. The struggles with France and Scotland had the most disastrous effects on the finances of the realm.

The Elizabethan Period, 1588.

The next Thames Defences were built by Queen Elizabeth in 1588, or 49 years later. In the meantime Higham Blockhouse, one of the five built by Henry VIII. in 1539—1540, had been "discharged" in 1553, *i.e.*, the cannon had been removed and the blockhouse disarmed. This was the year of the death of young King Edward VI., and five years before Queen Elizabeth came to the throne. Evidently Queen Elizabeth was much concerned about her Thames Defences, for in the very first year of her reign, *i.e.*, in 1558, she visited Tilbury, and shortly afterwards arrangements for building fortifications were put in hand.

The Earl of Leicester (curious coincidence) was Governor of the old Henry VIII. Blockhouse at Tilbury in 1558, as he also was 30 years later, in the Armada year of 1588, when the Queen visited Tilbury. Was this first inspection in 1558 the beginning of their "affaire de cœur?" The Earl of Leicester, "with his comely face," was the only one of the Queen's many suitors who ever really touched her heart. She denied him her hand for purely patriotic reasons, because she thought that it would be better for the government of the country if she remained unmarried.

The Queen's journey in 1558 is thus described, says Pocock:—"From Blockhouse where she should be set on land unto the outward Quarter of the Campe." The Queen's anxiety about the Thames Defences in 1558 was due to the fact that England was in the midst of war with France, Queen Mary having lost Calais in that year, after it had been an English possession since 1347, *i.e.*, for more than 210 years. There was also the prospect of even greater danger from Philip of Spain, the late Queen's husband.

We read that in 1565 "Jasper May was one of the Governors of

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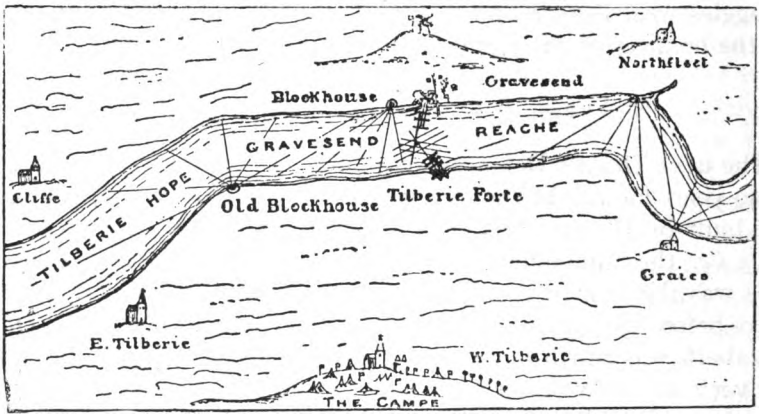
Gravesend Bulwarke." In Queen Elizabeth's time "the Forts (*i.e.* Blockhouses) of Gravesend and Milton each had a Captain, two soldiers, one porter and five grooms." This shows that Gravesend and Milton Blockhouses had not been "discharged." The Elizabethan scheme of Thames Defences was much the same, in principle, as that of Henry VIII.; indeed it was the latter's scheme modified and enlarged. The blockhouse at Higham dropped out, as above explained; the blockhouses at East Tilbury and Milton remained as before (see *Sketch No.* 3). Large fortifications were erected round the blockhouses of Gravesend and Tilbury (Hermitage or West Tilbury), using the old blockhouses as "keeps," and a bridge or barrier of boats was built across the river between these two forts.



THAMES DEFENCES.
IN 1588
Sketch No. 3.

The general idea was, as in 1539, to defend the Gravesend Reach of the river at two points, at its east or lower end and at its centre. The lower end was held by the Henry VIII. Blockhouse at the strategic position of Coalhouse Point (East Tilbury), the centre by the twin forts of Gravesend and Tilbury with bridge and barrier connecting them; and the outlying portions of the town of Gravesend to the east (in Milton Parish) were protected against bombardment from a hostile fleet by the Henry VIII. Blockhouse of Milton.

It seems curious that the Higham Blockhouse should have been dropped, leaving the lower end of Gravesend Reach to be held by one blockhouse only, on the Essex bank, and none on the Kent bank, although the deep water channel is on the Kent side of the river, and ships could in those days, by hugging the Kent bank, have passed up the river out of range of the cannon in East Tilbury Blockhouse.

The Elizabethan scheme of defence probably relied more on the very strong Gravesend to Tilbury line, and more or less abandoned

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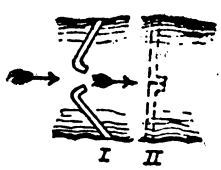
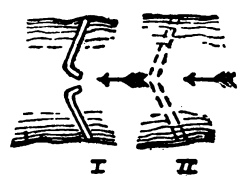
the advanced or first line (East Tilbury to Higham) of Henry VIII. On second thoughts I am doubtful whether the East Tilbury or Coalhouse Point Blockhouse was " alive " in the 1588 scheme. I notice that in the map (see *Sketch No.* 3) it is called " Old Blockhouse " and differentiated from the Milton one, which is called " Blockhouse," and whereas the establishment of Gravesend-Milton Blockhouses in Elizabethan times is on record, no establishment is given for East Tilbury Blockhouse. On the other hand there is no mention of the latter being " discharged," as is clearly recorded in the case of Higham Blockhouse ; also East Tilbury Blockhouse is shown in the map of Thames Defences in 1588 ; also no establishment is given for Tilbury Fort, which we know was " alive," neither have the drawings of Gravesend Fort been found yet, though we know that it was designed at the same time and by the same hand as Tilbury.

In the year 1588, the year of the Spanish Armada, " Gravesend was then fortified," says Pocock, " and western barges thither brought to make a bridge like that of Antwerp, to stop the entrance of the daring foe, and give free passage both to horse and foot, between Kent and Essex as occasion served." " In the year of the Spanish Armada," says Clifford, " the Earl of Leicester, then Governor of Tilbury Fort, blocked up the channel." Some authorities describe the chain of boats as being a " barrier " only, *i.e.*, simply a boom, to obstruct the enemy's ships ; others say it was also a bridge of boats to facilitate the passage of troops across the river in case the Spaniards effected a landing in the country. The design of this barrier (see *Sketch No.* 3) shows that it was of chevron shape in plan, the point projecting eastwards, *i.e.*, towards the enemy, the " cut " or gap being left in the centre. Presumably it was left open either to allow traffic through when there was no danger, or else to allow the enemy's ships through one at a time only, when they could be disposed of in detail, if necessary, from the ends of the bridge. From this design it would appear that this barrier was intended more as an obstacle than as a bridge. This salient angle would enable the forts on both banks of the river to enfilade the obstacle without firing into one another, but the shape would be a disadvantage for a floating bridge in a tidal river. The idea may possibly have been to " go into bridge " or close up the bridge with the help of the flood tide swinging in the long arms or the ebb tide the short returns at the end of the long arms (see *Sketches* 4 *and* 5),



Sketch No. 4.



Sketch No. 5.

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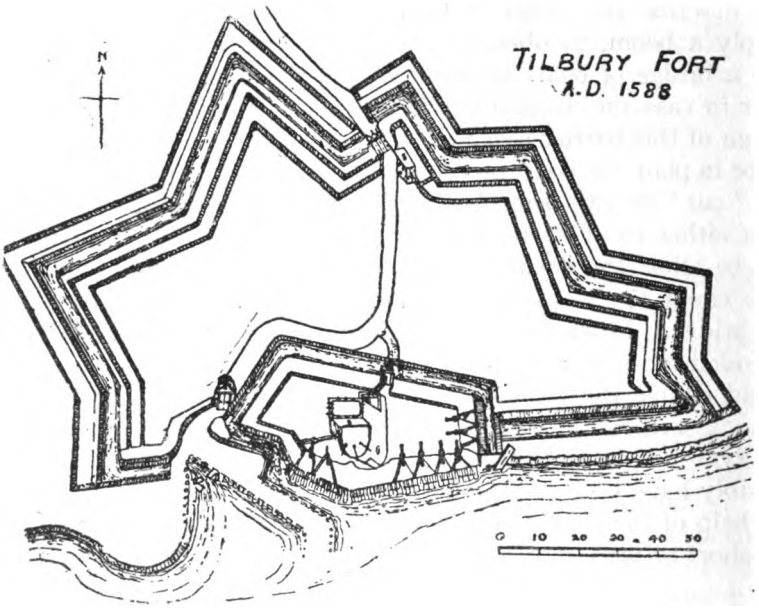
the latter arrangement being the better for enfilade fire. This scheme, however, makes no allowance for dead water at the turn, and its successful working would depend on "my friend the enemy" being obliging enough to attack when we wanted him to and not at a time of his own choosing or at the time which suited him best.

The design for Tilbury Fort shows a great advance in fortification on the Henry VIII. period of 49 years before; this is only to be expected in the wonderful Elizabethan period, England's "Golden Age." It is disappointing, however, to find that no Englishman was apparently qualified to design the fort; it was done by an Italian, Frederico Genebelli. Italy in that period, after its great Renaissance, must have been far more advanced and far more civilized than England. Shakespeare selected Italian foundations for most of his plays; in fact Italy was "the fashion." Genebelli also "prescribed" the bridge or barrier of boats and the fort at Gravesend, the design of which is not available. In this interval of 49 years fortifications underwent a mighty metamorphosis, from a small masonry blockhouse to a star-trace fort covering a large area. Genebelli's design for Tilbury Fort consisted of a star of six points and thirteen faces, including the river front (see *Sketch No.* 6). It



Sketch No. 6.

had two lines of defence, each with a wet moat filled from the river; the inner ring was built close round the Henry VIII. Blockhouse, using the latter as a "keep" or last stronghold; in this ring was also a gun platform for about eight guns. The outer line of defence

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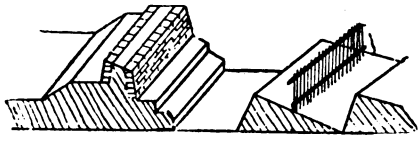
was much longer than the inner. The entrance to it on the north, or land front, was protected by a guardhouse and by a drawbridge; the inner moat was also protected by a drawbridge, so was the road which ran north and south, from the north or land entrance across the middle of the fort down to the causeway and to the approach from the river. The design of the parapet (see *Sketch No.* 7) shows



Sketch No. 7.

just as great an advance in the art of fortification as the plan. It is a high parapet type with the banquette raised well above the ground, both interior and exterior slopes are revetted with masonry walls, there are two wet ditches, the outer one strengthened by a palisade. In fact the whole design shows the "spacious days of good Queen Bess" and is a great credit to her. As regards the work of actual construction it is interesting to note that the labourers were paid 8d. a day, *i.e.*, a little more than is now, in 1915, paid for a single hour, and carpenters received 14d. a day, now they get on an average about 9s. a day!

"When the nation," says Millar, "was in dread of an invasion from Spain in the year 1588, fortifications were erected at Gravesend and Tilbury, and a fleet of battleships, to contest the passage of the river, moored here, whilst a large army encamped near the fort at Tilbury. On the 8th of August, 1588, Queen Elizabeth came in a State barge to Tilbury, to review her troops, and landed under a royal salute from Gravesend and the opposite fort." "In 1588," says Brabazon, "on both sides of the river fortifications were erected according to the prescription of Frederick Genebelli, an Italian . . . a barrier of boats was also built by the Governor of Tilbury Fort, the Earl of Leicester . . . on the 8th August, 1588, Elizabeth arrived in her barge at Tilbury Fort." "Leicester, whom the Queen loved till his death day, perished of a fever the same year (1588)."

On arrival at Tilbury the Queen rode to the house of the Squire of West Tilbury (just west of the village), where she stayed the night. Next morning she rode out to the famous Tilbury Camp, which was on the high ground, and dry sandy and gravelly soil, near West Tilbury Church. This army was one of the three armies of Volunteers raised in great haste when the threat of the Spanish Armada became known. One army was to guard against a landing on the south coast and an advance on London from the south. This army

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was concentrated near Portsmouth. Another army remained in London to protect the capital and the person of the Sovereign. The third was to guard against an advance on London from the east coast or from the banks of the Thames; this was concentrated at West Tilbury. The men in the latter army were all Volunteers from the counties of Essex and Kent, which, as usual, displayed great patriotism and public spirit in rapidly raising a large number of men.

The Queen rode out, inspected the troops, and then made them her well-known Tilbury speech, which was as follows:—

"MY LOVING PEOPLE,—We have been persuaded by some, that are careful of our safety, to take heed how we commit ourself to armed multitudes, for fear of treachery; but I assure you I do not live to distrust my faithful and loving people. Let tyrants fear! I have always so behaved myself, that, under God, I have placed my chiefest strength and safeguard in the loyal hearts and goodwill of my subjects. And, therefore, I have come amongst you, as you see at this time, not for my recreation and disport, but being resolved in the midst and heat of the battle to live or die amongst you all; to lay down for my God, and for my kingdom, and for my people, my honour and my blood ever in dust. I know I have the body of a weak and feeble woman; but I have the heart and stomach of a King—and of a King of England, too! —and think foul scorn that Parma or Spain or any Prince of Europe should dare to invade the borders of my realm, to which, rather than any dishonour shall grow by me, I myself will take up arms. I myself will be your General, Judge and Rewarder of every one of your virtues in the field. I know already for your forwardness, you have deserved crowns; and we do assure, in the word of a Prince, they shall be duly paid you. In the meantime my Lieutenant-General shall be in my stead, than whom never Prince commanded a more noble or worthy subject; not doubting but by your obedience to my General—by your concord in the camp—and your valour in the field, we shall shortly have a famous victory over those enemies of my God, of my kingdoms and of my people."

These wonderful words, a masterpiece of brief and appropriate oratory, help to explain that great power which this Queen exercised over men, and the genius she had for attracting around her the best talent in the country, and for then getting their very best efforts out of them. It is to be remembered that in those days the soldiery were very undisciplined and monarchs visited them at some risk; indeed, on this particular occasion, the Queen was strongly advised and begged not to go near this newly-raised army. Yet, in the course of a speech of a few sentences only, she must, with her fine sentiments and magnetic words, have roused their noblest feelings of patriotism and duty, have quickly won over any waverers, and by the time she had finished she must have had all the men shouting themselves hoarse and cheering for their Queen and country. "Towards the end of her reign," says Oman, "the people came to look

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upon her as a sort of second Providence, and credited her with an almost superhuman sagacity and omniscience."

In connection with Queen Elizabeth's inspection of Tilbury Camp, on the 9th August, 1588, it should be remembered that the final engagement between the British Fleet, under Lord Howard, of Effingham, and the Spanish Armada was fought on August 8th and 9th off Calais. The Armada had been bombarded, hustled and worried all the way up the Channel from Plymouth for a whole week; by the time the Spaniards reached the Straits of Dover they were demoralized. In this engagement on August 8th and 9th the Armada was shattered, and it fled into the North Sea before a strong southerly gale, and there dispersed. The British Fleet then sailed victorious up the Thames and reported the rout of the enemy after 10 days' continuous fighting. "They were welcomed," says Oman, "by the Queen, who had gathered a great force of Militia at Tilbury, to fight the Duke of Parma if he should succeed in crossing with Spanish troops from Flanders and invading the country." "Elizabeth behaved splendidly during the crisis, she had organized a strong army and put herself at its head, inspiring every man by the cheerful and resolute spirit which she displayed . . . it is unlikely that the Duke of Parma would have been successful against the numerous and enthusiastic levies which were ready to fight him."

There is a good deal of truth in the remark that "when a Queen is on the Throne the country is governed by men, when a King is on the Throne, by women." "Would that there were more of the Elizabethan spirit," says Lord Rosebery, "in England in these days." Queen Elizabeth returned to London the same day, 9th August, 1588, by barge from Tilbury.

The Charles II. Period of 1680.

The next period dealt with in the history of the Thames Defences is the 1680 or Charles II. period, *i.e.*, nearly 100 years later. The Henry VIII. Blockhouses no longer appear as part of the defence scheme. This is not to be wondered at considering that they were built 141 years previously. Tilbury Fort, as built by Queen Elizabeth, disappeared when Charles II. built his fort on the same site, but it is not known when the Henry VIII. Blockhouses of East Tilbury and Milton, and the Elizabethan fort of Gravesend were broken up either by man or by nature; the fortifications of Gravesend and Milton were in existence in 1650, and the one inside Tilbury Fort in 1725.

It is in a way, satisfactory to note that the Henry VIII. Blockhouse of Gravesend survived till 1834, *i.e.*, it nearly celebrated its 300th birthday. After prolonged negotiations it was eventually sold by the Crown to the Corporation of Gravesend, or rather to a committee

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of the inhabitants, for £7,000, and the present Terrace Pier was built on its site. On the other hand it is sad that this old blockhouse did not survive the sale of 1834. One of the advertisements used to announce this sale is now (1915) in the Royal Engineers Office at Gravesend. There are also in this office two large scale maps, one dated 1736 and the other 1780, both of which show this blockhouse clearly. It was used by Charles II. as a banqueting house, and perhaps this is why it survived and was kept in repair when the other blockhouses were allowed to go to ruins. If it had weathered that storm it would probably still be with us, and what a great addition a fort, dated 1539, would have been to the rich store of antiquities that Gravesend already possesses, what an attraction to visitors, and what an object of veneration to archæologists, historians, architects, and military engineers. Evidently in those days, *i.e.*, between 1588 and 1680, a soldier's life was not altogether a happy one. In 1631 the pay of the garrison (gunners) of Gravesend Fort was six years in arrears, and of Tilbury Fort seven years.

In 1650 Gravesend is described by a visitor as follows, says Pocock: "We walked about the town, where we saw its strong Castle, defended by ramparts and bastions of earth, furnished with a good number of cannons, and a great garrison within it as being a place of consequence." The Charles II. scheme for Thames Defences appears to have consisted of one fort only—at Tilbury. It was a one-fort design like the King Alfred and the Henry IV. schemes, except that the former placed his solitary fortification at Milton (next Gravesend), and the latter placed his solitary fort at East Tilbury village.

The fortifications in the Elizabethan scheme, viz., the large forts at Tilbury and Gravesend and the blockhouses at Milton and possibly at East Tilbury (or Coalhouse Point), also now disappear from the scene as live defences, though the Henry VIII. Blockhouse of Milton, as previously stated, lasted till 1834, or another 150 years.

Charles II.'s fort of 1680 at Tilbury seems to have been built on the same site as the Elizabethan fort of 1588. The latter must have been demolished (or rather what was left of it after nearly a hundred years, a period which included the great Civil War and the Commonwealth), as no traces of it remain. There was, of course, very little masonry in the 1588 fort; it was mostly earthwork, except the Henry VIII. Blockhouse, the guard-house at the north entrance, the foundations of the two drawbridges and the south entrance gate, and the retaining walls or revetment of the parapet.

For the design of the fort, Charles II. consulted, as Elizabeth had done before him, the greatest authorities on permanent fortification in Europe at the time. It was the golden age of the art of fortification, and the leading exponents were Coehorn (a Dutchman, who

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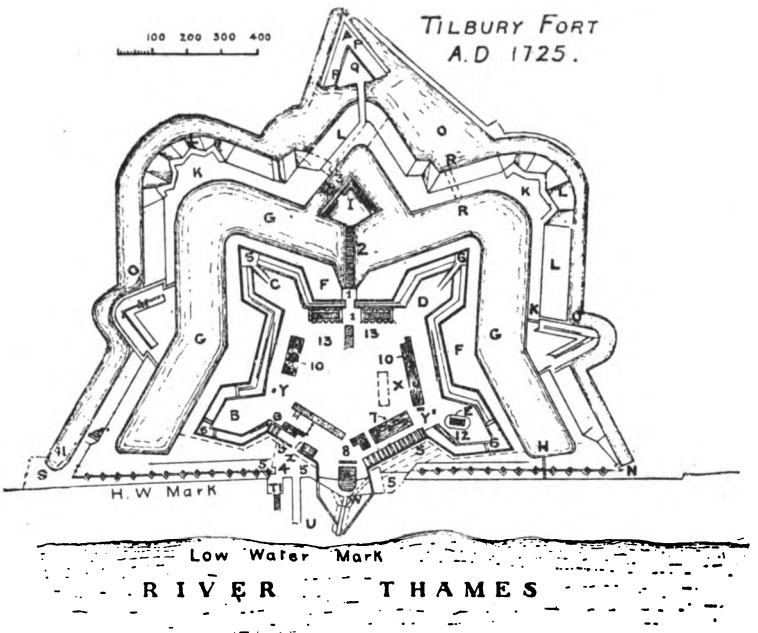
lived 1621 to 1704, and who was known as "The Vauban of the Netherlands"), and Vauban, who lived 1633 to 1707. Vauban was the great French military engineer, who then had a world-wide reputation. He is the outstanding figure in fortification design, Antwerp being his most famous creation. He invented the famous "bastion trace," with its ravelins, sally ports, curtains, bastions, caponiers, escarps, counterscarps, galleries, etc. The principles which he laid down were being taught in this country over 250 years after his birth—surely a unique record in such an ever-varying and continually progressing art as fortification.



Sketch No. 8.—From a Government Plan, dated A.D. 1725.

A Blockhouse.
B West Bastion.
C North-West Bastion.
D North-East Bastion.
E East Bastion.
F Berme.
G Moat.
H Sluice.

1 Ravelin.
K Covered Way.
L Parapet of the Glacis.
M Place of Arms.
N Two Lines of Guns.
O Avant Fossé.
P A Redan and a Redoubt in it.
Q Diques.

R Floodgate.
S Redoubt.
T Wharf and Crane.
U Landing Bridge.
W Powder Bridge.
X Cisterns.
Y Offices.
Z Water Gate.

1 Land Part.
2 Main Bridge.
3 Bridge of the Ravelin.
4 Gunners' Guard.
5 Barriers.

6 Barbette Platforms.
7 Stove House.
8 Master Gunner's Store Room.
9 The Chapel with Guard Room under it.

10 Barracks.
11 New Sluice.
12 Old Powder Magazine.
13 New Powder Magazine.

"In Charles II.'s reign," says Brabazon, "Government resolved upon the erection of a regular fort at Tilbury in March, 1667. Sir Martin Beckman is said to have prepared the plan, having recently superintended one at Sheerness. Sir Bernard de Gomme, engineer-general, was also employed in both places, probably under the

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direction of Sir Martin, engineer-in-chief. For the principle of their design they were indebted to Coehorn and Vauban, who were then giving instruction in Europe. From Coehorn came the happy suggestion of erecting the foundation upon piles, driven so deep that, being pointed with iron, they entered the solid rock adjoining the chalk hills on the other side. Next the river is a strong curtain with a fine gate, called 'The Water Gate.' The Governor of Tilbury Fort claims the ferry which passes between his premises and Gravesend."

This ancient privilege explains why it is that nowadays the Army is allowed free passage on the Gravesend-Tilbury ferry steamers. In the good old days this ferry, which ran between Tilbury Fort and the Henry VIII. Blockhouse at Gravesend, was the perquisite of the governor of the fort, and as pay in the Army then was, so to speak, "few and far between," and often many years in arrears, these ferry tolls probably formed a large proportion, if not the whole, of his emoluments.

The Governor built the inn, appropriately called the "World's End," for the accommodation of people waiting to get across the ferry. "The Governor," says Pocock, "claims the ferry from his premises to Gravesend, on the same terms as the Corporation of Gravesend and Milton do theirs, and he has built for the greater convenience of passengers a public house for his ferrymen to dwell on the spot (emphatically termed the 'World's End')."

Tilbury Fort has had a long line of Governors—the Governor in the Elizabethan period was the Earl of Leicester. Other Governors were: In 1650, Colonel George Compton; in Charles II.'s time, the Duke of York. This Duke of York was the King's brother, and New York was called after him. His daughter married the Prince of Orange in 1677, and afterwards became Queen of England (William and Mary, 1688—1702). The Duke of York's title was "Governor of Gravesend and Tilbury," which shows what an important place Tilbury Fort was considered to be in the reign of Charles II., as well as in that of Queen Elizabeth. The Governor in 1818 was Sir George Lowry; in 1824 Lieut.-Colonel Hawker.

In Charles II.'s time the staff of Tilbury Fort consisted of one governor, one lieut.-governor, one storekeeper, one clerk, one master gunner. The salary of the governor was £300 a year and that of the master gunner £41 10s. "Tilbury Fort, opposite to the Blockhouse at Gravesend," says Pocock, "may be looked upon as the Key to the City of London. . . . The Esplanade of the Fort is very large, and the Bastions are the largest of any in England . . . a Platform . . . in which are planted 106 Cannon, generally carrying from 24 to 47 pound ball; a Battery as terrible as important to the place . . . so that they must be daring men who will venture in the largest ships to pass such a Battery."

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Tilbury Fort, as designed in the Coehorn and Vauban manner by Sir Martin Beckman and Sir Bernard de Gomme, "Engineer-General," consisted of a bastion trace forming a regular pentagon with five bastions (see *Sketch No.* 8), two on the land front, the north-east and the north-west, and three on the river front, the east and the west, with the "water bastion" between them. The latter bastion was never completed and eventually a "powder bridge" was built on the site. The main entrance was by the beautiful carved stone "water gate" between the west and the water bastions. The fort was surrounded by two wet moats, of which the inner was 150 ft. wide. Between this and the outer moat or "avant fosse" there was a low command parapet or "covered way." From the sally port between the north-east and north-west bastions, *i.e.*, to the north or land front, the "main bridge" over the moat led to the ravelin. Similarly there was in the outer moat a "redan with a redoubt in it." Near the water gate was the "land bridge" (the present stone causeway). The fort had an underground water tank and an underground powder magazine in the east bastion, and two blocks of barracks. The old Henry VIII. Block-house of 1539, *i.e.*, some 140 years before, is shown as being in the centre of the water bastion. At the salient of each bastion there was a gun platform "en barbette." The chapel, "with a guard room under it," was added in 1715, and two more above-ground powder magazines in 1716 to 1724. A gun platform for 31 guns, extending along the river bank on either side of the water bastion, was added at about the same period.

The fort itself has a high command parapet, with a high masonry wall of red brickwork, with white stone quoins, string course and weep holes, on its outer side. The architectural beauties of these buildings of the Charles II. and early Georgian periods have already been mentioned. The fort was begun in 1667 as regards the preliminary work, and was built between 1682 and 1687. The ornamental water gate is dated the 34th year of Charles II., *i.e.*, 1683, counting from the last year of Charles I., or 1649.

It is sad that Charles II. had, like Queen Elizabeth before him, to seek inspiration from foreign authorities in his design for Tilbury Fort, but then he had, except for a few months, never been in the British Isles. "He was," says Oman, "Continental in his manners, thoughts and life."

The new fort at Tilbury was apparently built as a protection against the Dutch. In 1666 "the English Fleet had not recovered from the disaster in the Downs, for Charles II. had squandered on his palace and harem the liberal grants which Parliament made him to repair his Navy. While the seas were unguarded a Dutch squadron slipped up the Thames . . . and held the Port of London

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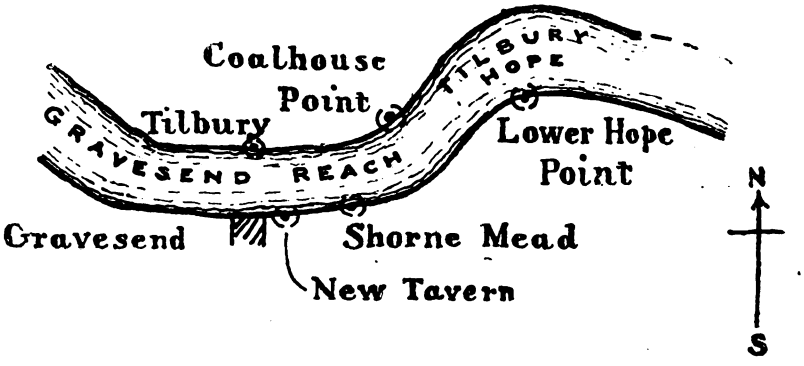
blockaded for some days." In the following year the project for a new fort at Tilbury was put in hand. In 1671 Charles II., in alliance with Louis XIV., of France, declared war on the Dutch.

THE LATE GEORGIAN PERIOD, 1796.

The next period dealt with in the history of the Thames Defences is the late Georgian period, 1779—1798, *i.e.*, 115 years later. During this period a fort was built at Lower Hope Point, another at Shornemead in 1795—1796; a third at Coalhouse Point in 1798; and a fourth at New Tavern, Gravesend, in 1779-1780. The first three forts were dismantled in 1820, after Waterloo and the long peace which followed. These forts had a life of about 22 years only.



Sketch No. 9.

They were thus easily the shortest lived fortifications in the history of the Thames Defences. Tilbury Fort of 1680 was, of course, still "alive" in this defence scheme, and, indeed, was "alive" 200 years after its birth. The designs for Lower Hope Point, Shornemead and Coalhouse Point Forts may have been similar, as New Tavern was built 16–18 years before the other three. Lower Hope Point and Shornemead mounted four guns (24-pounders) each.

The 1796 scheme of Thames Defences had the fortifications spread over a large area, as in the schemes of Henry VIII. (1539) and of Queen Elizabeth (1588), except that the area defended was extended further down stream, *i.e.*, to Lower Hope Point. The defences thus protected the west end of Sea Reach, both ends and the centre of Tilbury Hope Reach, and the east end and centre of Gravesend Reach. The two previous schemes above mentioned had not touched Sea Reach at all. The forts were symmetrically placed, two on the Kent bank of the river and two on the Essex bank, and arranged so as to "break joint" in plan, and one (New Tavern) was placed so as to protect the town of Gravesend (just as had been

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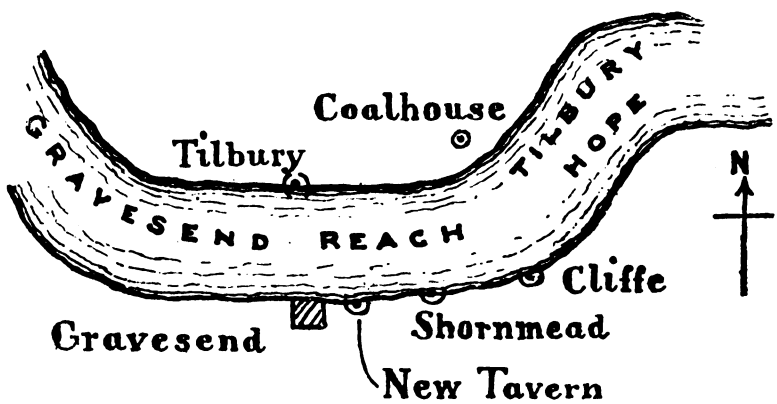
done by King Alfred 900 years previously, and by Henry VIII. 260 years previously), and with its twin fort opposite (at Tilbury) the ferry over the Thames and the centre of Gravesend Reach.

The design of the forts of this period at Lower Hope Point, Coalhouse Point and Shornemead is not available, but was probably similar to that of New Tavern. The latter was, however, built 16 years earlier. The design of the fort at New Tavern, Gravesend, can be seen in a valuable old map, dated about 1780, in the Royal Engineers Office at Gravesend. The fort ran along the river bank in one line from the old Henry VIII. Blockhouse (*i.e.*, the present Terrace Pier), eastwards, and then joined on to a closed fort of irregular star trace (similar to that of Tilbury Fort built by Queen Elizabeth in 1588), the present New Tavern Fort. The parapet was of earth, at a gentle slope on the outer side; the gorge defence was in the west face of the closed fort and consisted of a loopholed brick wall barracks. Magazines, etc., were built inside the closed fort, some under the parapet.

"At the lower end of Milton Place," says Millar, "is the fort, erected in 1778, which so completely commands the river at this



Sketch No. 10.

point, with a sweep of open country besides that an enemy would at much hazard attempt to pass the mouths of its cannon. The state of public affairs at this period (1779) produced the construction of additional military works at Gravesend, as well as other arrangements in connection with the general system of defence."

It is interesting to note that at the time of the mutiny at the Nore (April, 1797), of the Channel and North Sea Fleets, Shornemead Fort fired on a large ship full of mutineers and made her strike her flag. New Tavern Fort was built as a defence (with Tilbury Fort opposite) against the Fleets of France, Spain and Holland. France declared war on England in 1778 after the disastrous American War.

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Spain followed suit in 1779 and Holland in 1780. A period of 10 years' profound peace then followed from 1783 to 1792.

The other three forts of this period were the outcome of the French Revolution which began in 1789. The French Convention declared war on George III. in 1793 and this great war lasted with but two short intervals till 1815. In 1796 Spain joined France, and England had now, as in 1778 to 1780, to face the united Fleets of France, Holland, and Spain. This accounts for the three additional Thames forts being built in 1796—1798, *i.e.*, for precisely the same reasons as New Tavern Fort had been built 18 years before. "The Fleets of France, Spain and Holland if united," says Oman, "would outnumber our own; and for the next three years (1797—1800) the safety of England hung on the power of our admirals to keep the junction from taking place . . . if once beaten the English Fleet could not prevent an invasion of England . . . and the victorious armies that had overrun Germany, Holland, and Italy from coming ashore in Kent or Sussex."

THE MID-VICTORIAN PERIOD OF 1870.

The next period we come to in the history of the Thames Defences is the mid-Victorian period of about 1870, *i.e.*, about 100 years after the last period. In this period New Tavern Fort and Tilbury Fort were reconstructed and modernized in 1868—1871. New gun platforms to take up-to-date artillery were built, also new magazines. This defence work was probably the outcome of the Crimean War.

In 1874 new forts were built at Coalhouse, Cliffe and Shornemead. These defences were also probably the result of the Crimean War as the preliminary work was begun in 1861 to 1863. The general scheme of Thames Defences of this period was a modification of the late Georgian scheme of 100 years earlier. The defences were concentrated on the west end of Tilbury Hope Reach and on the east end and centre of Gravesend Reach, *i.e.*, Cliffe Fort was substituted for Lower Hope Point Fort and the protection of the west end of Sea Reach abandoned.

Cliffe Fort was placed as a twin fort to Coalhouse Fort, and just opposite it. Shornemead and Cliffe Forts were placed close together on the Kent bank, probably because the deep water channel runs close along that bank of the river. The design of the three forts at Cliffe, Shornemead and Coalhouse was quite different from anything previously attempted. They are all three in the Crimean War or Todleben style and consist of a roughly rectangular trace, built of masonry, the high outer walls faced with granite similar to those at Sebastopol, which were bombardment-proof and which resisted our heaviest naval guns in the Crimean War. This period might be called the "stone age."

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The barracks, magazines, etc., are placed on the perimeter, leaving a small open courtyard in the middle. The entrance is by a heavy bullet-proof doorway. The emplacements for heavy guns are, of course, on the river faces of these closed-in fortifications. Each fort is provided with underground water tanks.

One point of great interest in these three forts is that they were built by Gordon of Khartoum, who was stationed at Gravesend, as Commanding Royal Engineer, when he was a "Captain and Brevet Lieut.-Colonel," from 1866—1871. Gordon did not approve of the scheme of defences given him to build, in fact he considered the scheme a bad one and, in his usual fearless way, stated so officially. For this he was badly reported on by his superior officer, who described Gordon as not fit to be an Army officer and implied that he should be removed.

It would be interesting to know if this superior officer lived to see the world-wide sorrow which Gordon's death caused, not only throughout the British Empire, but in every great nation, friendly or hostile, and whether he lived to change his opinion.

The Late Victorian Period of 1900.

The last chapter of the history of the Thames Defences is that of the late Victorian period of 1900. In this period one fort only was built, namely, Hope Battery.

The late Georgian scheme of 1796 had a fort at Lower Hope Point. This fort was abandoned shortly afterwards, and in the mid-Victorian scheme of 1870 there was no fort at Hope Point, but one higher up the river at Cliffe instead.

In the late Victorian scheme of 1900 there was a reversion to the late Georgian type, and a fort was again built at Hope Point. This fort had a very short existence of a few years only, a shorter life even than its ancestor or predecessor, which, at any rate, lived for 22 years.

Nevertheless, this fort is of great interest, as it marks a new era in the progress of the art of fortification design, the era of metallic forts. The gun platforms and gunners' shelters, etc., are all made of steel plates, the men's barracks are an entirely separate building, as also are the officers' quarters, the office, engine room, etc., *i.e.*, the fort consists of a number of detached buildings not enclosed in any way or protected by a parapet, earth-mount, masonry wall, moat or fence. This "iron-age" fort marks another new era in the employment of electric searchlights, with coast defence artillery, thus enabling the guns to be used with effect by night.

It will be seen from these Notes that the Thames Defences cover a period of over 1,000 years, from A.D. 893 to 1900. The following examples of fortification design can still be seen "in the flesh," so

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to speak:—The Tilbury Fort of the 1680 period, with additions of the 1720 period; New Tavern Fort of the 1780 period; Coalhouse, Shornemead and Cliffe, also additions to Tilbury and New Tavern of the 1870 period; and Hope Point of the 1900 period. Altogether a fine museum of architecture, probably as fine a museum as can be found anywhere in the British Isles in as small a compass, with its examples of Charles II., Queen Anne to early Georgian, late Georgian, mid-Victorian and late Victorian styles.

If these Notes help to arouse interest in the history and development of the Thames Defences in particular, and of fortification design and fortification architecture in general, they will have served their purpose, especially so if they result in further research work being undertaken, and the history carried back earlier than 893, or more information being obtained about the 893—1900 period.

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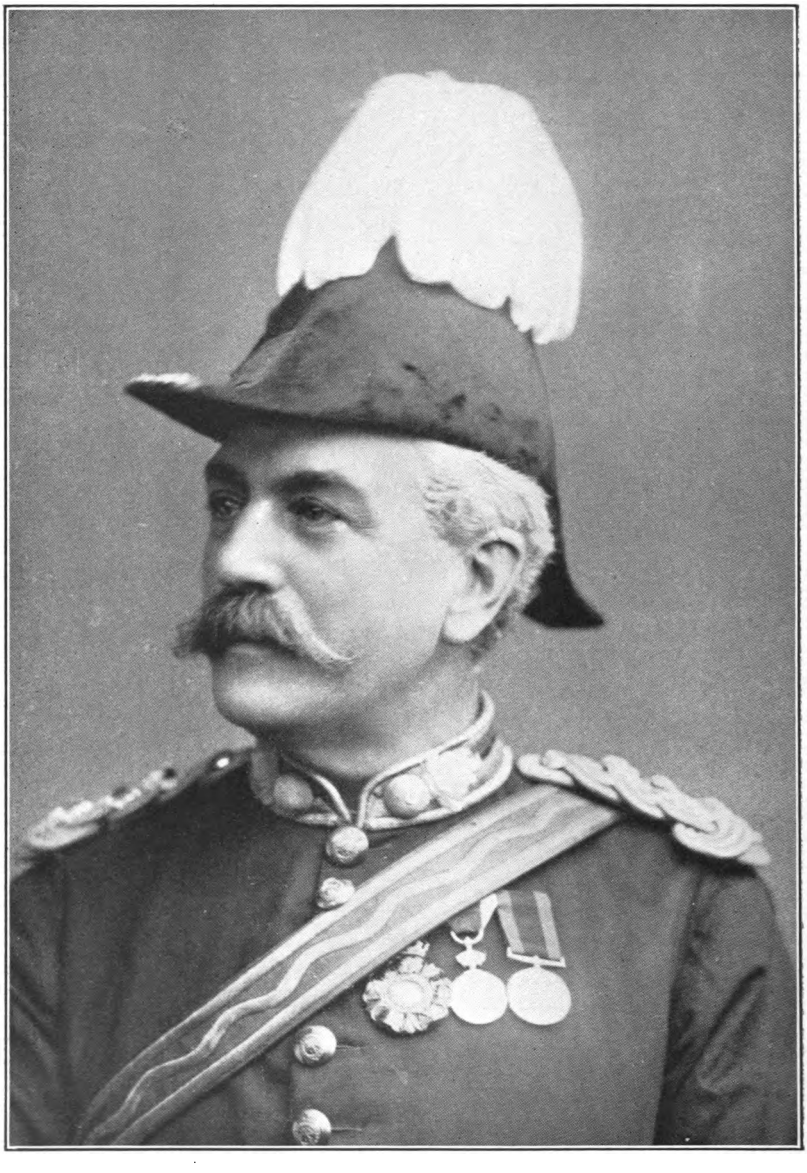

Colonel Augustus Le Messurier, C.I.E.

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MEMOIR.

COLONEL AUGUSTUS LE MESSURIER, C.I.E., R.E.

COLONEL AUGUSTUS LE MESSURIER, C.I.E., Royal (Bombay) Engineers, died at his residence, 57, Mount Avenue, Ealing, on 19th February last in his 79th year, having been born at Eden Hall, Bombay, on 23rd June, 1837. He was the eldest son of Augustus Smith Le Messurier, Esq. (of an ancient Guernsey family dating back to 1259, William Le Mazerier, who was Sheriff of London), and Sarah Anne Taylor Morley, widow of James Morley, Esq., Barrister, and daughter of Capt. Starr Wood, H.M.S. *Chesterfield*, by his second wife, Elizabeth Travers.

Augustus Smith Le Messurier, Esq., was a barrister-at-law and practised his profession in Bombay. In 1831 he was appointed a Puisne Judge, one of three, but as immediately after, it was ruled there were only to be two in future, the appointment was disallowed; but on 10th September, 1833, he was promoted to be Advocate General of Bombay, and retained this post till 15th December, 1856.

Augustus, his eldest son, was sent home in 1841, and never saw his father again until he arrived in England in October, 1854. In 1847 Augustus was sent to Kensington Proprietary School, which vied with Cheltenham and Wimbledon Schools in sending up their boys direct to Addiscombe and thence to India, under the *régime* of the Honourable East India Company.

At school he showed great aptitude for sketching and survey, as well as athletic sports, especially cricket and rowing, as many of his brother officers would remember at Chatham in 1867, when he coached and successfully stroked a four-oared crew called the "Mulligatawnies" in the R.E. and other regattas on the Medway.

At school in the early "fifties" he was the prime mover in initiating sports, when he took many prizes, high pole jumping being his great forte. He was frequently on the river Thames, and greatly interested in boat building and the great oarsmen of the day. He seldom missed the Oxford and Cambridge Universities Boat Race; likewise at Lords he was always present at the great matches of the season.

Notwithstanding his pleasurable pursuits he devoted a great deal of his time to work for others, notably as a Governor and Member of the Committee of Almoners of Christ's Hospital, especially when the move to Horsham was in contemplation, and subsequently he paid visits to Horsham and to Hertford.

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On 1st February, 1855, he joined Addiscombe as a Cadet, passing through the ordinary routine with an extraordinary number of extra drills for trifling offences. He obtained his Commission on 12th December, 1856, with 12 others (John Herschell heading the list, a son and grandson of two celebrated astronomers), in the Honourable East India Company's Engineers.

Early in 1857 he joined the R.E. Establishment at Chatham, then under Colonel H. Sandham, R.E., with the local and temporary rank of Ensign.

He was keen on reconnaissance and survey work, was also employed in the operations of blowing up the old Rochester Bridge, and on one occasion was nearly drowned in the diving dress off the Dockyard wall. Yachting, boating, and boxing were his chief amusements, with many a night spent on the marshes after curlew, wild duck, etc.

He left London for India on 8th January, 1859, landed at Bombay on 12th February, and at that place was a guest of Mr. W. Frere, Bombay Civil Service (elder brother of Sir Bartle Frere), for some 10 or 12 days before proceeding to Poona, when he was posted to the Bombay Sappers. He lived at Kirkee with his great school and college friend, William Merriman, until ordered on field service to Okamundel in September. He was present at the Storming of Beyt and Siege of Dwarka, etc., and was present with Charles A. Goodfellow (Bombay Engineers) when that distinguished officer gained the Victoria Cross.

On return from active service he held appointments in the Public Works and Railway Departments, and in 1862–63 was employed on the Bombay Harbour Defences under Colonels Walter Scott and de Lisle (both of the Bombay Engineers), having as his companions his old schoolfellows, William Merriman and George Oldham, the trio being inseparable, and were known in society as the "Triumviri," or "The Three Graces." The Oyster Rock Battery stands as a monument to his memory, and on revisiting it in 1890 with his lifelong friend was pleased and astonished with the excellent work he had superintended so many years before.

Between 1863 and 1866 he held appointments as Executive Engineer at Nassick, Nuggur, and Kirkee, and in 1864 became Deputy Consulting Engineer for Railways. In 1865 he paid a brief visit to England, Ireland and Holland, and in 1866 was posted to Chatham for a "Refresher" course of military duties, under Colonels Fitzroy Somerset, and Lennox, V.C., meeting his old friend (William Merriman) there, similarly engaged. The duties he found light, but with those of Mess and cricket secretaries, yachting, rowing, hunting, shooting, etc., he passed an enjoyable time. Bicycling had then been instituted, which he took up in earnest, this standing him in good stead in after years as President of the Ealing Cyclist Club. Although a

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heavy weight, he rode well to hounds, was a fair shot and in India was known as a good "whip," driving four in hand and tandem; also a "big game" shot.

Towards the close of 1867 (4th November) he left Chatham and embarked at Gravesend with Oliver St. John (after Sir Oliver B. St. John, K.C.S.I.) for active service in the Abyssinian Expedition, under Sir Robert Napier (after Lord Napier of Magdala). He was placed in charge of the water supply, earning the sobriquet of "Pumps."

Lord Napier in his despatch of 1st June, 1868, says:—"The water supply at all the stations (where the most perfect order was required to water quickly many thousands of animals) all formed part of a great military work on which the campaign had been supported. The well sinkers under Lieut. Le Messurier have rendered excellent service throughout the campaign, and the Royal Engineers have rendered invaluable services during this expedition, which has given such an ample field for their employment."

Lieut. Le Messurier was present at the action of Arogi, and at the Storm of Magdala and death of King Theodore. At Magdala he was one of the very first inside the fortress. He returned to Bombay on 24th June, 1868, was reposted Deputy Consulting Engineer for Railways next month, and in July, 1870, acted as Consulting Engineer for Lieut.-Colonel John Salisbury Trevor.

On 3rd January, 1871, he married, at Seetabuldee, close to Nagpore, Kathleen Elizabeth, daughter of Major-General Geo. Gill Moxon, B.S.C., in October following was posted to Sind as Deputy Consulting Engineer for Railways for charge of the Guaranteed Railways, and in April, 1875, acted for three months as Consulting Engineer at Lahore.

From October, 1875, to April, 1876, he was deputed as Secretary, Railway Transport Committee (experiments in embarking and disembarking troops from railway trains), at Delhi, and so was present at that place during the visit of H.R.H. the Prince of Wales (after King Edward VII.), when he was presented to His Royal Highness.

In May, 1876, he went to England and was sent on special duty to Brussels Exhibition to collect information regarding military railways. At this time he was promoted to the rank of Major.

In January, 1877, he was present at Delhi at the Proclamation of the Queen Empress, and shortly after was made Under Secretary (Superintending Engineer, 2nd Class), Railway Branch, on Special Duty.

In November, 1878, he proceeded on field service to Afghanistan with the Kandahar Column, under General Sir Donald Stewart, K.C.B., when he held the post of Brigade Major to Colonel R. H. Sankey, R.E. (after Sir Richard Sankey, K.C.B.). He was present at the action of Saif-u-din, was mentioned in despatches, *London*

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Gazette, 7th November, 1879. He did a great deal of excellent work as Brigade Major of Engineers, and Colonel Sankey, Commanding Engineer, wrote: "To Major Le Messurier, Lieuts. Call and Childers I owe more than I can well express." For these services he obtained his Brevet of Lieut.-Colonel and returned on 22nd October, 1879, to Simla, being posted shortly after (28th November, 1879) Chief Engineer of Mysore State Railway, Bangalore.

In February, 1880, he went to England, and in April he was appointed by the Secretary of State to visit forests in the east of France and report on timber-cutting operations, when he visited Nancy, Epinal and Gerardmer, in the Vosges. He returned to Bangalore the end of May, 1880, and continued to hold his appointment till November, 1885, but during this interval he paid a visit of three months to England in 1883, and was on duty at the Calcutta Exhibition for a month in December, 1883.

In November, 1885, he left on furlough to England for two years and travelled *viâ* Egypt, Palestine, Asia Minor and Turkey, etc., arriving at Ealing 31st March, 1886. A month or so after he attained the rank of Colonel. He was present at the opening of the Indian and Colonial Exhibition as the Mysore Delegate on 4th May, 1886, and was presented to H.M. the Queen by H.R.H. the Prince of Wales; and on 2nd August was presented at Osborne with the C.I.E. by H.M. the Queen. Shortly after he paid his first visit to the Channel Isles.

On 14th September, 1887, he started alone for India *viâ* the Caucasus, Trans-Caspia, Bokhara and Persia, arriving at Bombay 9th December, 1887, the journey thus occupying about three months, and was then on special duty to the Government of India till February, 1888.

By the end of the year 1887 his notes were printed and placed at the disposal of the Viceroy, Lord Dufferin. The Viceroy granted him permission to publish his narrative a few days before he left India, and so it happened that much of the story relates to events which were then a year old.

The authorities had by no means approved of his having undertaken this journey, but they allowed the publication, although by no means as he had originally wished. His notes, etc., were in three books and three of illustrations splendidly got up with photos, etc. These books bore the titles of—

1. '*From England to the Caspian*' (1A) *and*, '*Caucasus. Illustrations.*'
2. '*Trans-Caspia*,' (2A) *and* '*Trans-Caspia. Illustrations.*'
3. '*Persia*' (3A) *and* '*Persia. Illustrations.*'

The books are unique, but were published as private and confidential, and copies were only sent to the Viceroy, the Commander-in-Chief, Duke of Connaught, Major-General Pemberton,

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the Q.M.G., Mrs. Le Messurier, and his lifelong friend, Colonel William Merriman.

He was allowed to publish *London to Bokhara and a Ride through Persia*, containing 320 pages, with 18 illustrations, which was the outcome of the three mentioned above, but of course a great deal of interesting information had to be omitted at the instance of the Government.

In February, 1888, he was appointed Consulting Engineer for Railways at Calcutta, and in September and October of the same year he paid a visit of some weeks to Assam; while early in 1889 he visited Burmah on special duty to inspect the railways. This duty lasted two months; and on both these occasions he was accompanied by his wife.

Soon after his return from Burmah he was appointed Chief Engineer and Secretary, Public Works Department, Punjab, and this important post he retained for rather more than three years, but on 23rd June, 1892, he had to vacate the appointment, having attained the age of 55.

In the year 1890 he paid a flying visit to England, travelling *viâ* Spain and returning *viâ* Darmstadt and Florence, and in the following year he served in the Black Mountain Campaign (Medal).

On 23rd June, 1892, his services were placed at the disposal of the Military Department, and during the latter part of that year he travelled up the Sutlej Valley and through Kulu, Lahoul and Ladak to Kashmir for nearly six months, till Christmas Eve, 1892, and retired from the Service 27th May, 1893, nearly 37 years since the date of his first commission.

He was a man of fine physique and commanding presence, a noble character with the courage of his opinions, kind and gentle, a thorough officer, gentleman and sportsman, with shrewd common sense and vast knowledge, a man of travel and no mean author. He was a member of the Royal Geographical and Royal Zoological Societies and a Governor of Christ's Hospital, and in all these institutions he took a very keen and lively interest. In addition to his book on Kandahar in 1879 and that on Persia and Bokhara he published a work on the "Game, Shore, and Water Birds of India" in 1874, which by 1887 had attained its third edition.

He had a very varied career, was four times on active military service and had four medals. He served in many parts of India in the Public Works and Railway Departments such as Bombay, Sind, Mysore, Punjab, Assam, Burmah, and Central Provinces, and he always served with distinction. He visited Cashmere, Persia, and the Caucasus while he was still in the Service, and after retirement he still cherished his love for travel, for in the year 1897 he travelled round the world for six months. In 1899 he cruised round the British Isles accompanied by his eldest daughter; visited Norway the same year, and in 1900 cruised in Trinity Yacht *Irene* to the

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Scilly Isles. In 1907 he visited Newfoundland, Labrador, Nova Scotia, Canada and Boston.

His robust health gave way about two years before his death, and he died at Ealing on 19th February and was buried on 24th at City of Westminster Hanwell Cemetery, some miles from Ealing.

The cheery and genial presence of Gus Le Messurier will be sadly missed by his many friends.

A great deal of information has been furnished for this brief memoir by his lifelong friend, Colonel William Merriman, C.I.E., who first knew him at school in 1847, and was closely in touch with him during a great part of his life.

The writer of this short memoir knew Colonel Le Messurier well, having been with him at Addiscombe and Chatham in early days; met him again at Bombay and Bangalore, and saw him occasionally in after years, and thoroughly appreciated his fine manly and cheery character.

This brief record of a busy life cannot more fitly be closed than by adding an appreciation of him by his eldest daughter.

"It is indeed I feel a privilege to write these few lines about one who was 'lovely and pleasant in his life,' and who seemed to have peculiarly the gift of sympathetic relationship with his fellow men. His open generous nature appeared to love instinctively and gladden everyone with whom he came in contact; friends, acquaintances, even a beggar in the street, all responded to that intuitive keen sense of fun, humour and human sympathy which radiated from his gracious, joyous personality like sunshine."

"To those of his immediate family circle his life was a never-ending source of joy and inspiration impossible to express in words, so full it was of deep affection and kindly ways. He had a great love of travel, not only for its own sake, but for the valuable knowledge it enabled him to get, and this is evidenced in the criticisms of his book, *London to Bokhara*, a journey he was the first to make over a hitherto impassable route. His love of books and study and unusual powers of observation are evidenced in his book on the Birds of India, also in papers on various subjects compiled during his busy life, and the course of a long and varied career."

"During his last illness he remained bright and cheerful and uncomplaining to the last, and his lively interest in men and matters unabated to the end."

He leaves a widow, one son and three daughters to mourn his loss.

His son, Darel, is a captain in 83rd Wallajabad Light Infantry, and is married. Of the three daughters the two eldest are married, Maud to Major-General W. Dalrymple, C.B., Colonel Commandant, Connaught Rangers; Sylvia to Mr. Arthur Preston, while the third, Dorothea Violet Claire, is unmarried.

HENRY M. VIBART, *Colonel, R.E. (Retired)*.

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NOTICE OF MAGAZINE.

REVUE MILITAIRE SUISSE.

No. 2.—February, 1916.

THE ITALIAN ARMY.

Impressions from the Front.

The *Revue* article is accompanied by photographic reproductions containing views of the country in which the Italian Army is, at the present time, operating.

The subject is divided into sections as follows :—

I. *The Pacifist Policy of Italy.*—It is pointed out that the Tripoli Campaign in no way modified Italian foreign policy ; this had up to July, 1914, continued to be governed by the provisions of the Treaty creating the Triplice. The Italian Government considered the provisions of this Treaty as a sufficient safeguard against any aggression from external sources against their country. In consequence, Italy had not, prior to the outbreak of the present hostilities, made any elaborate military preparations to meet the contingency of a European war, but had diverted her resources into channels which would rehabilitate her financial position and improve the social welfare of her people.

There was by no means any general feeling of optimism in Italy regarding the military situation during the pre-War days ; many far-seeing men had in their public speeches and by their writings warned their countrymen of the necessity of taking measures to defend the Austrian frontier of Italy. Schemes for fortifying a number of strategic centres on the Italo-Austrian frontier had been studied, but financial reasons had prevented the matter from being pursued to a practical conclusion ; a few forts were constructed on the Trentino and in Cadora, but a project for establishing a fortified line on the Livenza and all other similar proposals were completely abandoned. Further, the Italian Government also held its hand in the matter of improving the strategic railway communications on the Austrian frontier.

On the other hand, Austria had, in recent years, taken active steps to put her Italian frontier in a state of defence as is evident from the number of forts constructed in the last decade or so in the Trentino, in the Dolomites, in the valley of the Fella, the basin of the Plezzo, at Tolmino, Gorizia, and places south of those mentioned. The railway network on the Italian frontier was also extended by the Austrian Government at the cost of some hundreds of thousands of pounds ; lines being constructed, in some cases, in mountainous regions where they could have no value except for military purposes. Everything seemed to point to the preparation by the Austrian General Staff of an offensive plan of campaign against Italy.

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Some of the higher officers of the Italian General Staff had urged the construction of strategic railways, but as soon as the Austrian Government heard that the subject had been mooted it at once made a remonstrance. The pacifist tendency in Italy was so strong that the Italian Government yielded to the wishes of their north-western neighbour.

The reliance placed by the Italian Government on the provisions of the Triple Alliance as providing a guarantee for the independence of Italy was clearly demonstrated in the spring of 1914; on the transfer of political power from Signor Giolitti to Signor Salandra, alternative programmes were put forward in regard to expenditure on the Italian military establishments—one proposed by General Porro would have involved an "extraordinary" expenditure of 16 millions sterling and the other by General Grandi involving an expenditure of 7¼ millions sterling. The latter proposal was accepted; and this at a time when Germany had raised 50 millions sterling, by a special war tax, for increasing her already bloated armaments, and Austria was also busy with military preparations. The average of the annual expenditure on military establishments in the important Continental states for the five years preceding the War represents the following outlay per head of population:—Austria, 7s. 9d.; France, 13s. 3½d.; Germany, 12s. 8½d.; Italy, 5s. 2½d.; Russia, 5s. 9½d.

At the outbreak of present hostilities Italy was not in a position to take part in a European War; however, the real reason why Italy did not join the two Central Empires in August, 1914, did not arise from this fact, but arose from her statesmen taking the view that no *casus fœderis* existed which imposed an obligation on their country to take part in a war under the provisions of the Treaty binding the Triple Alliance.

II. *The Preparation.*—The Italian General Staff and the Departmental Services spent the period from August, 1914, to May, 1915, in completing arrangements for bringing the armament, etc., of the Italian Army up to the requirements of a modern war.

At the beginning of the present war Italy mobilized 12 Army Corps (consisting of 94 Regiments of Infantry); 2 Grenadier Regiments; 12 Regiments of Bersaglieri (each having 1 battalion of cyclists); 8 Regiments of Alpini; 36 Regiments of Field Artillery; 2 Regiments of Mountain Artillery; 10 Regiments of Siege Artillery; 29 Cavalry Regiments; 6 Regiments of Engineers; one Battalion of Technical Troops; one Battalion of Aviators. In the period which elapsed subsequent to the date of its first mobilization, the Italian Army has been largely increased, so that the figures given above no longer hold good.

III. *The First Task of the Army.*—Although it was Italy that declared war against Austria and not *vice versâ*, yet in the first instance the Italian Army played a defensive *rôle*. This was due to the fact that the first objective of the Italian higher command was the securing of a line more easy to defend against the Central Powers than that afforded by the actual frontier of Italy.

At the beginning of the War the Trentino was, on the Austrian side, defended only by fortress troops and territorial battalions, whose military value was a doubtful quantity. The Austrian General Staff had

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anticipated that Italy would require nearly four weeks in which to complete her mobilization; but it soon became evident to them that the Italian Army would be ready to take the field within a fortnight. The Austrian General Staff had made their arrangements on the assumption that a clear fortnight would be available in which to transfer troops from Galicia to the Trentino. This will explain why it was that at the beginning of hostilities the Austrians confined themselves to the defence of certain very important strategic positions only, such as that of Pasubbio, and employed inadequate numbers of territorial troops for the purpose, allowing Italy to put her field army into movement and thus to occupy at a very early date important defiles and commanding positions along the Austrian frontier. The Italians could have easily penetrated further into Austrian territory than they did, but in doing so they would have run a serious risk of being cut off had Germany immediately pushed forward sufficiently large forces to effect this purpose.

The first objective of the Italian Army was the occupation of the dominating positions at the outlets of the Guidicarie and the Adige Valleys, and on the Trentino front, so that defence works might be constructed at these points for the purpose of holding the enemy in check with a relatively small force. Under these circumstances the main body of the Italian Army could be held in hand in order to repel any large body of troops which the Germans might send against Italy. The results aimed at by the Italian General Staff were attained.

IV. *The Italian Offensive.*—Towards the end of June, 1915, the Italians were already in occupation of the positions, in proximity to their frontier, which they were expected to hold on to against Austro-German armies attempting to invade Italy. At the period last mentioned the Italian Engineers commenced the construction of strategic railways, semi-permanent works, concreted entrenchments, dug-outs, etc. From the date of their success at Castel Nuovo, on the Carso, in mid-July, 1915, the Italians carried on a vigorous offensive warfare which resulted in putting into their hands the high-lying plateau in this region. Towards mid-June, 1915, the Italians had also conquered Plava, and its heights on the Isonzo, and were able thus to establish themselves in Austrian territory on the line Gorizia-Tolmino.

The Italians having assumed the offensive along their whole front pursued it with great vigour. A period of calm then ensued which was utilized for the purpose of constructing defence works on the line gained so as to form a new line from which the offensive could be further pursued. The new offensive movement was begun by the Italians towards the middle of October last, and resulted in a considerable advance forward.

On the Carso the Italians gained ground in the valley of the Doberdo and occupied the spurs on the northern slopes of Saint Michel towards Gorizia, and, in consequence, commanded the routes leading to the fortified position of Sabotino. The Italians also gained the ground, near Monte Santo and Kruck, which may be said to constitute the natural ramparts for the defence of Gorizia. Immediately to the south of the place last mentioned, Italian troops crossed the Isonzo and pushed for-

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ward to the vicinity of Saint Andrea and compelled the Austrians to withdraw their artillery to the east of Gorizia. Much progress was made by Italian troops on the Tolmino and Plezzo sectors, several Austrian forts being silenced in the latter sector.

In the Dolomites the Italian offensive resulted in the conquest of the Cortina D'Ampezzo Basin and of certain parts of the frontier region in the Dolomites. In the Trentino, the Italian offensive gave the Italians possession of the Bezzecca, the valleys of the Concei, Ledro and Lagarina, which form a semicircle about Riva; the railway communications to the place last mentioned were also completely cut off by the Italians.

V. *The Difficulties to be Overcome.*—In Austrian official circles there has always existed a latent hope that the territories lost to Italy in 1859 and 1866 would some day be reconquered. The Grand Duke Ferdinand, the heir presumptive to the throne of the Hapsburgs, has very deeply cherished the idea that this would come about some day and he has devoted much care to the pursuit of a policy intended to accomplish this purpose. Evidence of this is to be found in the first line of forts constructed in Austria along the Italian frontier; and in the frequently repeated refrain, which occurs in the Grand Duke's speeches, that Lombardy and the Venetian provinces must be reconquered.

The Austrian Government has caused a fortified position to be constructed, as a first line, at an enormous expenditure, around the region in which are situated the Stelvio and Tonale Passes, Lardaro, Riva and Valarsa; there is also a very important second line of works round Trente. These works are armed with very powerful guns and are provided with ample barrack accommodation for their garrisons. In some cases, a single fort has involved the expenditure of a million sterling. The entrenched camp of Gorizia, which covers the region enclosed in the "great triangle" at the angles of which stand Monte Santo, Sabotino and Saint Michel, is a marvellous example of the art of the Austrian military engineer. The defences of this area are so designed that should an enemy obtain a foothold in one of the angles of the "great triangle" he can at once be brought under an intense artillery fire from the guns at the other two angles of this triangle. In spite of this, however, the Italians, having early in their campaign against Austria forced their way into one of these angles, have continued to hold on to the positions thus gained.

Italian soldiers have exhibited a tenacity of purpose and a courage in attack in every way equal to similar qualities exhibited by Russian and Serbian soldiers in Galicia and in Serbia; they have frequently broken through strongly entrenched lines held by the Austrian troops.

VI. *The Co-operation of the Various Arms.*—Those who have had the good fortune to visit the Italian troops at the Front have put on record the opinion that the co-ordination between the different branches of the Italian Army is perfect; the only branch which has broken down is the Army Postal Service. In spite of the extremely difficult nature of the country in which parts of the Italian Army are operating—in the mountain regions supply and ordnance parks have at times had to be organized in localities at an altitude of 8,000 to 9,000 ft. above sea level—nevertheless, the troops have been supplied with the utmost

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regularity with rations, ammunition and stores, except in those rare cases in which the roads to the parks are commanded by Austrian artillery and the roads can therefore only be traversed during hours of darkness.

VII. *The Supreme Command.*—The supreme command of the Italian troops at the Front is vested in the King of Italy; his Chief of Staff is General Cadorna who has been responsible for the measures taken in recent times in connection with the reorganization of the Italian Army.

VIII. *The Infantry.*—A description of this arm of the service is given in the *Revue* article, under three subdivisions, namely (*a*) the *Élite*, (*b*) the Territorials, (*c*) Bersaglieri and Alpini. Italy has adopted military service on the basis of two years with the colours. The physique of the recruits enrolled annually is good and they are said to become rapidly acclimatized to the varying conditions of heat, cold and humidity, which prevail in the localities in which the Italian Army was quartered in peace times. In recent years a grey-green uniform has been adopted for the Italian Army, and when it mobilized for the present war all the troops were clothed in garments of this colour. At 32 years of age the Italian soldier passes from the Active Army into the Territorial Force —corresponding to the Swiss Landwehr—and remains therein until he completes the 39th year of his age. Men belonging to the Territorial Force are largely drawn on to fill up the supply and transport units, and to carry out the other administrative services in the second line. Men of this class are recognizable by the numbers and distinctive badges on their headdress. Territorials are also allotted to the combatant arms, and they have taken part in much of the fighting on the Isonzo and on the Carso during the present war. The Bersaglieri were first formed in 1836, the intention of the military authorities being to have a special Corps d'Élite in the Piedmontese Army for the recruits with physique above that of the average soldier. This corps from its earliest days has had to undergo a training which put the men to a severer physical test than that to which the remainder of the Army had to submit. The Bersaglieri are more lightly equipped than the ordinary infantry, the trained man in the corps being really a highly skilled marksman possessing a very high degree of mobility. Service in the Bersaglieri is very popular in Italy. The Alpini were first raised in 1873; the men for this corps are drawn from the mountain regions; each of the battalions of this corps receives recruits from the Alpine zone in which its headquarters have been established. The whole of the service of the Alpini battalions is spent among the Alps.—(*To be continued*).

A Talk on Aeronautics.

The article on the above subject which appeared in the January number of the *Revue* for the current year (*vide R.E. Journal* for April, 1916) is concluded in the number of the *Revue* under review.

Dirigibles.—From the earliest days of the present war aircraft have been allotted to the belligerent armies on both sides. Since dirigibles must be based on hangars, they were unable to move forward with the armies to which they belong. The German Army had much bad luck with their dirigibles at the beginning of the War; if reports are to be

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believed, by the 3rd September, 1914, they had lost 7 out of 12 Zeppelins in its possession. In the first days of the War, the factory at Friedericshafen was busy, day and night, turning out airships at the rate of one per three weeks. The air raids made by the Allied aviators on the German Zeppelin stations and harbours, as also the aerial attacks made by German aircraft on the British Navy and on the coastal area of England, are dealt with in some detail in the *Revue* article.

Since the occupation of Belgium by German troops hangars for Zeppelins have been constructed in many parts of the occupied territory. Reference is made in the *Revue* article to the use made by the British Navy of utilizing airships as aerial patrols in connection with the transport of troops and material across the English Channel.

It is stated that up to the time of writing of the *Revue* article the Italians had lost one dirigible and the British none, against which must be put a loss of 23 Zeppelins by the Germans.

Aeroplanes.—In the early days of the War, the aeroplanes on both sides were, at times, flown at so low an altitude that they were hit by the rifle bullets fired against them.

The French had from the beginning taken the precaution to provide protection for the fuselage of military machines by suspending steel shields, having a V section, below it. The Germans, however, only provided protection in their military machines for the engines and the seats of the pilot and observer. At the beginning of the War, aeroplanes were alone employed for scouting purposes and acted individually or in pairs; the Germans were first notified of the march of Allied troops on von Kluck's flank, which led to the hurried retirement of the German Army from the Marne, by aeroplanes so employed. During the progress of the battle on the river last named, it was a French aviator who discovered and reported the gap between two of the German armies, which gave the Western Allies an opportunity to score a success.

It is stated that the empty train which was sent by the Belgians full steam ahead out of Antwerp in order to interfere with the German railway service was discovered in sufficient time by a German aviator who was able to avert the impending collision between it and a German troop train.

Aeroplanes were also employed both by the Belgian, as well as the German Army, to disorganize the march of supply columns by dropping bombs on the wagons moving along the roads.

The Germans succeeded, in the early days of the War, in capturing a large number of French aeroplanes and other material at Rheims, which was then an important military flying centre. The Germans were, however, able to remove all their own aeroplanes, and stores connected therewith, when obliged to evacuate Habsheim, near Mulhausen.

Since the date at which the opposing armies came to a halt and became engaged in trench warfare, which still continues, aerial photography has assumed a very important *rôle*. For instance, a map of the Morto in the Gulf of Saros was mapped from 35 photographs taken from aeroplanes; the existence of an important Russian camp, in a wooded region of Poland, which was completely hidden from view, was only discovered after photographs taken by a German aviator were

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developed. A smudgy appearance was noticed in a photograph taken in this region in two zones among the trees; these were correctly diagnosed to be smoke from camp fires; many other cases of the valuable part played by aerial photography are on record.

The well-known use made of aeroplanes for locating hostile batteries and signalling their sites by circling round the emplacements, by wireless telegraph messages and in other ways is referred to in the *Revue* article.

Early in 1915, the Western Allies started the campaign of air raids on a large scale; aeroplanes were at that time employed by squadrons instead of singly or in pairs. The first of these raids was carried out on the 12th February, 1915, with 34 aeroplanes and seaplanes; the objective being the German coast batteries at Ostend and Zeebrugge. A list is given of some of the more important of the raids carried out, between the 16th February and 24th September, 1915, inclusive, as reprisals in respect of German aerial attacks on Paris and other French towns; in one of these raids, that of 26th August, 60 aeroplanes visited the Forest of Houltust and, at the same time, 62 aeroplanes attacked Dilligen. From the beginning of the War to the end of June, 1915, French aviators had made 37 attacks on German towns against 80 similar attacks made on French, English and Russian towns by German aviators.

Aeroplanes have also been employed during the present war to maintain communication between besieged fortresses and field armies, for instance, as in the case when the Russians were besieging Przemysl.

The French have constructed a triplane machine capable of carrying a crew of six men. It is stated that engines of 100 and 120 h.p. are being substituted in some cases for the lower-powered engines previously carried by aeroplanes.

The practice has also been adopted of providing aeroplanes with two engines in order that higher speeds may be attained.

In all the belligerent countries very large numbers of pilots are being trained. The instruction is, as a rule, progressive; after spending a short time at one of the depôt schools, the partially trained recruits are sent to centres in rear of the armies; here they are employed on guard duty, and finally they go forward to the fighting line. The supply of recruits is said to exceed the wastage caused by the War.

Already a distinct type of aerial tactics has been developed during the progress of the War; new features in aerial warfare are expected to make their appearance in the year of grace 1916.

A Retrospect.

The Return of a Contingent; Freiburg, 1499.

The article under the above heading commenced in the *Revue* for January, 1916 (*vide R.E. Journal* for April, 1916), is concluded in the number of the *Revue* under review.

The supposititious conversation referred to in the previous review is continued; this part of it deals mainly with the subject of the arms and appliances in use in the Swiss Army of the 15th century.

Those who have devoted themselves to the study of the development of military weapons from early times will find much of interest in this article.

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How can the German Front be Pierced?

The *Revue* article is based largely on the views of Capt. Laffargue, of the 153rd (French) Regiment of the Line, an officer whose experiences in the present war well qualify him to express opinions on the subject dealt with by him. Capt. Laffargue, having taken part in the Battles of Nancy and Ypres and having, in consequence, been an eye-witness of the colossal effort made by the Germans on these two occasions, was much impressed by the utter failure of the German troops to carry their attacks to a successful issue. He was one of the many officers who had come to the conclusion that the German front could not be pierced; but having been wounded in May, 1915, he was able to spend some time meditating over his experiences. Capt. Laffargue has altered his original opinions and having recorded his present views the Commander-in-Chief of the French Armies has caused the same to be printed at the public expense and to be distributed to the troops in the field. Capt. Laffargue has made a valuable contribution to the military literature on the tactics of the present-day warfare and there is a strong consensus of opinion in France that his conclusions are on the whole sound.

The author of the *Revue* article opens by asking the question: "Is it possible to pierce the German front?" In reply to this question he points out that "experience has shown this to be possible" and cites the fact that in May and September the French actually did pierce the German front both in Artois and in the Champagne, although it is true that no advantage was taken on these occasions of the French successes for reasons which have yet to be disclosed.

As might be expected Capt. Laffargue's views have not been accepted in their entirety; criticisms have been levelled against some of his doctrines. A brief *résumé* of these criticisms appears in the article under review.

Capt. Laffargue is of opinion that an intense artillery bombardment *must* precede every attack by infantry in order that a way may be prepared for the advance of the latter arm. The criticism directed against this proposition is that a cannonade will but increase the vigilance of the troops on the defence who will rightly assume that increased activity on the part of the enemy's artillery must be a prelude to an attack. Being forewarned, the defenders will without doubt make dispositions by manning trenches, etc., to defeat the plans of the attackers; in such a case failure on the part of the attackers is almost certain. The critics argue that if, on the contrary, the infantry, taking advantage of darkness, were to launch an attack without any previous artillery bombardment, the chances of success would be greater and the artillery could in such a case be employed to create a "barrage" in rear of the trenches attacked in order to prevent supports from being pushed forward. Briefly, the counter-proposal amounts to this: launch the infantry attack without noise and previous artillery preparation; do not open artillery fire until the infantry have reached the enemy's trenches, in the case where the attack succeeds, or until the infantry are thrown back, in the case where the attack fails. Practical experience does not, it is said, encourage formation commanders to adopt the method advocated by Capt. Laffargue's critics. The writer of the *Revue* article

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expresses the opinion that "artillery preparation is rendered absolutely necessary owing to the proved inefficiency of all other means which have been proposed for the destruction of the obstacles along an enemy's front. It will be so much the worse for the defenders if the artillery bombardment succeeds in drawing them into their front line trenches."

As is well known, the ruse has frequently been adopted in the present war of bringing about a sudden interruption in the artillery bombardment of the attack and then as suddenly reopening it against the same section of the enemy's trenches after the elapse of 10 minutes. In such cases the real attack has only been launched after a succession of false alarms. In the early days of the War the Germans were often deceived by such tactics and suffered heavy loss owing to a premature manning of their fire trenches; they know better now.

It was the practice according to the tactics of former times to make the "centres of resistance" the objective of an attack; this had an effect similar to seizing the horns of a bull. To-day, no advantage is gained by the adoption of the tactics referred to and, in consequence, it is against the "curtains" and not against the "bastions" that attacks are now launched; although, of course, every effort is at the same time made to effect as great a destruction of the "centres of resistance" by artillery fire as is possible.

Machine guns being the weapons which inflict the heaviest losses on the attacking infantry, every effort must be made to locate their emplacements in order that as many of the machine guns as possible may be put out of action before the infantry attack is launched. Artillery officers appear to be shy about expending ammunition on machine-gun emplacements; Capt. Laffargue is strongly of opinion that not only should the artillery concentrate fire on what are known to be machine-gun emplacements, but even on all points suspected of being used for harbouring machine guns. He points out that the artillery should not expend their efforts on the destruction of machine guns days before an attack, but as late as possible during the period of the artillery preparation, and that the same rule should be applied in regard to the silencing of the enemy's artillery.

Although infantry can be pushed forward during the artillery preparation, it is not possible for them to attempt the occupation of the enemy's first line trenches during this period. It is advocated that the infantry attack should be preceded by a grenade attack and the use of lachrymatory bombs against the sections of the enemy's trenches which it is intended to seize. Capt. Laffargue points out that the French have the munitions for this purpose, but he urges that more powerful types should be supplied to the army than those now in use.

A short description is given in the *Revue* article of the general lines on which the French attacks on the German front have been planned and carried out; briefly, an intense artillery fire is brought to bear on the enemy's fire trenches and the obstacles along the sectors to be attacked, the ground in rear of these sectors are also searched with artillery fire so as to cause as much disturbance to the enemy's troops in billets as possible, a point is made of shelling the roads leading from the fire trenches towards the rear, and particular attention is paid by

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the artillery to the defenders' artillery and machine guns. After the bombardment has been kept up, with intervals of silence, for a sufficient time to unnerve the enemy and to disorganize his defence arrangements generally and conditions favourable for an attack have been created, the infantry are launched forward. The attackers' artillery then directs its attention to the second line trenches of the defenders; it also creates a "barrage" so as to prevent troops being rushed forward for a counter-attack and at the same time endeavours to knock out any of the defenders' machine guns, the positions of which may have remained masked until the final stages of the attack. The importance of dealing with these machine guns promptly cannot be exaggerated; the artillery ought on no account to overlook their duty utterly to crush machine guns at every stage of the attack as soon as their existence becomes manifest and more particularly those coming into action during the final stages of the attack. It is suggested that aeroplanes can also co-operate at this stage of the attack by dropping bombs on reinforcements, on bridges, viaducts, exits of villages, etc.

NOTES AND NEWS.

Switzerland.—Colonel Feyler contributes an article to the *Revue* on "The Affair of the Swiss General Staff." Colonel Feyler states that his article is written with the object of making known the views of the French Swiss. In this article is investigated the causes which have led up to the scandal arising from the indiscreet conduct of Colonels Egli and Wattenwyl. A mistake appears to have been made by the Federal Council in appointing Colonel Wille to the Chief Command.

It is said that this officer was best known in Switzerland by reason of his display of insubordination rather than for his military capacity. General Wille appears to possess strong German sympathies which he has not been at any pains to conceal. The violation of the neutrality of Luxemburg and Belgium profoundly moved the French Swiss; however, not only did the violent acts of the Kaiser's troops leave the German Swiss unmoved, but in Swiss military circles admiration was openly expressed for the conduct of the German Army. The military measures adopted by the Swiss General Staff at the outbreak of war also created disquietude in the minds of the French Swiss; these measures indicated clearly enough that whereas France was looked upon as a possible enemy to Switzerland, Germany, on the other hand, was considered in the light of a possible ally. The mistrust of the French Swiss by the Swiss General Staff is held to be the fundamental cause of all the unrest which has prevailed in Switzerland since August, 1914.

This number concludes with promotions, etc., in the Swiss Army and a bibliography of publications of military interest.

W. A. J. O'MEARA.

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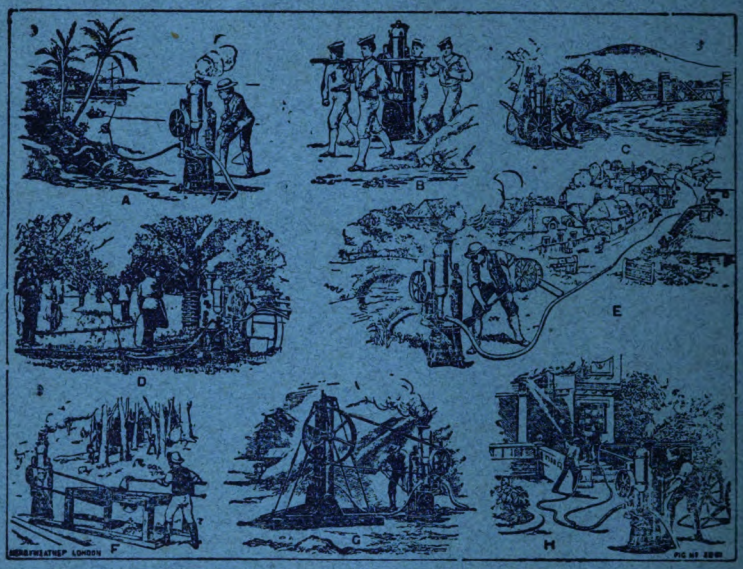

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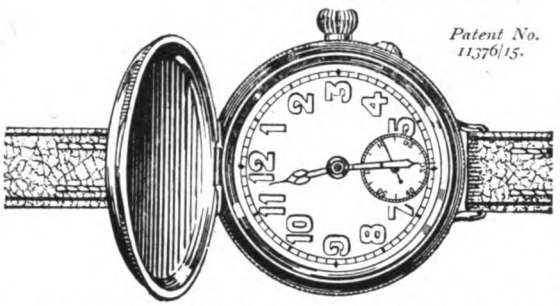

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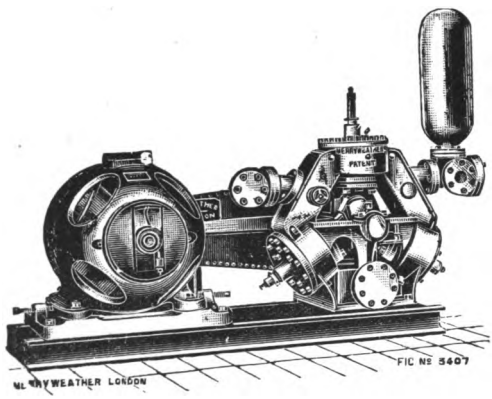

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THE JUNCTION OF THE INDIAN AND RUSSIAN TRIANGULATION WORK IN THE PAMIRS.

IN No. 1, Vol. XX., *R.E. Journal* (July, 1914), by the courtesy of the Surveyor-General of India, we were enabled to reproduce from the *Records of the Survey of India* an account of the Junction of the Indian and Russian Triangulation Work in the Pamirs.

We have recently received Vol. VI. of the *Records of the Survey of India*, which is completely filled with an account of the completion of the Link and we are again indebted to Colonel Sir S. G. Burrard, K.C.S.I., F.R.S., R.E., Surveyor-General of India, for the opportunity of placing before our readers some account of the wonderful work carried out. The volume which has been produced under the direction of the Surveyor General, is dedicated as under :—

To the
MEMORY
of
HENRY GORDON BELL
Lieutenant Royal Engineers
Assistant Superintendent Survey of India
Who lost his life on the Taghdumbash Pamir on June 25th 1912
THIS ACCOUNT
of the
COMPLETION OF THE TRIANGULATION
between
INDIA AND RUSSIA
with which his name will ever be associated
is
DEDICATED
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THE AUTHORS.

An interesting Preface is written by Lieut.-Colonel G. P. Lenox Conyngham, R.E., and in the course of it he says :—

" This preface would not be complete if it failed to allude to the great loss that the Survey of India sustained in the death of Lieut. H. G. Bell, R.E., who died on the 25th of June, 1912, at Lup Gaz, close to the Mintaka Pass. He had made his way to the terminus of the Russian Triangulation and had met Colonel Tcheikine of the Russian Topographical Service and his detachment. Parting

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with them he began observations on his portion of the work, and had completed three stations when he was taken ill and died in a few days. He was an officer of high character and ability and his untimely death cut short a career which gave promise of distinction.

"The whole undertaking from its beginning, after the passing of the Resolution by the International Geodetic Conference of 1909, to its completion in the autumn of 1913 has been under the direction of Colonel Sir Sidney Burrard, K.C.S.I., F.R.S., R.E., and all who have taken part in it have to thank him for wise counsel, friendly interest, hearty encouragement and firm support."

The Introduction, a most interesting part of the work, is from the pen of Lieut. (now Captain) K. Mason, R.E., Assistant Superintendent, Survey of India. He writes—It is difficult to trace back the inception of any scheme that has taken more than a lifetime to accomplish, or to discover who first conceived the possibilities that may be the outcome of that scheme. If we look back into the early annals of the Survey of India, we find that it was Major William Lambton, of the 33rd Regiment, who first proposed the measurement of an arc of the meridian, by which geodesists would be able to determine the figure of the earth. With infinite trouble, Lambton collected from various sources the necessary instruments, and the measurement of the original base began on the 10th April, 1802, near Madras. Subsequently Colonel Lambton became first Surveyor-General of India, and died while on tour at the age of 70*. Colonel Sir George Everest succeeded him as Superintendent of the Great Trigonometrical Survey of India and Surveyor-General, and he conceived the great gridiron system of triangulation in India and carried it to the foot of the Himalaya. Sir Clements Markham, in *A Memoir of the Indian Surveys*, writes, "He had completed one of the most stupendous works in the whole history of science. No scientific man ever had a grander monument to his memory than the Great Meridional Arc of India. Everest's was a creative genius. The whole conception of the survey, as it now exists, was the creation of his brain." It would be very interesting if we could now know whether either Lambton or Everest ever contemplated the possibility of triangulation extending from the ninth parallel to the sixtieth. During the years that followed, work was commenced and carried on in the mountainous regions to the north, and we find Capt. Montgomerie commencing, in the spring of 1855, the triangulation of the mighty mass of mountains between the plains of India and the frontier of Tibet. He used a 14-in. Troughton and Simms theodolite, and carried this heavy and cumbersome instrument up many rocky peaks, some of which were 16,000 ft. in height. The location of his series was across Kashmir to Baltistan as the

* The Government Gazette of the time gave his age at 75.

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regions to the west were not then under British control, and were inhabited by slave-dealing and robber tribes.

In the summer of 1888, Major Durand's Mission was sent to Gilgit, to enquire into the causes of an outbreak of hostilities between Kashmir and the tributary states of Hunza and Nagar; this resulted in the permanent establishment of a British Agency at Gilgit. In the winter of 1891, the Indian Government were forced by the intrigues of the rulers of Hunza and Nagar with our powerful neighbour across the border, to interfere, and the territories of these two mountain states became part of the Indian Empire.

During the year 1892, Sir Martin Conway led an exploration party in Nagar subsequently crossing into Baltistan, while smaller parties of officers on leave and duty have also increased our knowledge of the frontier in these parts. In 1896, the Pamir Boundary Commission commenced its labours, and settled the boundary between Russia on the north and the province of Wakhan in Afghanistan; but I do not think that the survey work accomplished in connection with this Commission was done with any view to linking up the great systems of Russia and India. The only connection between it and the Indian triangulation was by means of rays to very distant peaks, which had been intersected from the existing triangulation on the south; while an enormous gap separated it from any Russian work.

In 1909, Mr. James de Graaff Hunter, of the Survey of India, was deputed to commence a Principal Series* near Rawal Pindi emanating from the base Nerh-Khagriana of the North-West Himalaya Series and this triangulation had reached the neighbourhood of Shardi by the end of 1910. The work was of the highest order of accuracy. It was intended to complete this series to Gilgit and thence by following the Indus Valley to make a connection with Colonel Montgomerie's series in Baltistan.

At the same time, Colonel Tcheikine, of the Russian Survey, had begun a series from the base Ourtak-Tchoucour-Machali-Goudour (latitude 39° 33′, approximately), on the Trans-Alai Range, and had reached the neighbourhood of Pamirski Post.

During the International Geodetic Conference of 1909, which met in London, the possibility of a link of accurate triangulation between the Indian and Russian systems was discussed. It was suggested that the connection might be effected across the northern boundary ranges of India to the Chinese or Russian Pamirs, and a Resolution to this effect was proposed and passed. This appears to be the first occasion on which a connected and accurate system of triangulation from the south of India to the north of Russia was contemplated,

* The co-ordinates of the stations and intersected points of this series are included in Appendix A.

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and the possibilities discussed. The complete series would be far the largest in the world, and it was anticipated that the results would yield matter of the greatest scientific interest. The Surveyor-General of India received this proposal in the early part of the year 1911.

Lieut. H. G. Bell, R.E., who succeeded Mr. Hunter, carried the Principal Series as far as Gilgit during the summer of 1911. Great difficulty was experienced owing to an early start after a late winter, as the snow lay as low as 8,000 ft. On one station the portable lightning conductor was struck, and the detachment was greatly delayed by inclement weather, while in the Indus Valley, a severe earthquake caused a cliff to be precipitated into the river, destroying the road and thus adding to the difficulties of the work.

Having reached Gilgit, Lieut. Bell and his assistant, Mr. Wainright, left that place on the 1st August, to reconnoitre the Darkot route and the Hunza Valley respectively with a view to finding the best means of effecting a junction with the Russian triangulation. Marching *viâ* Yasin, Bell reached the Darkot Pass and examined the peaks in the vicinity. He found the extensive glacier, rising on the pass, much intersected by crevasses, and only passable in the very early morning. The highest peak, about 19,370 ft., west of the pass, was found to be quite inaccessible for triangulation purposes, and the neighbouring peaks, though lower, were useless owing to high unclimbable peaks to the south and south-east. From Darkot, Bell visited the approaches of Garmush, 20,564 ft.; here also he found that the glaciers in the neighbourhood were extremely dangerous, and the slopes very liable to avalanches. The Darkot-Askuman Pass was crossed, and a peak ascended with a view to obtaining a more extensive reconnaissance of Garmush and the other peaks of the Sakiz Jarab Range, but the term "Glorified Matterhorns," which has been applied to the Karakoram Peaks further to the east, was found to be equally applicable here. In a letter, written from hereabouts, Bell mentioned that he doubted whether the peaks would be accessible for an experienced party of climbers, and that it was a physical impossibility to take an instrument up any one of them. A move was then made to the Karumbar Valley, in the hope of finding a possible connection by this route. But again the difficult nature of the obstacles encountered caused at any rate the temporary abandonment of this line.

Mr. Wainright meanwhile made a reconnaissance up the Hunza Valley towards the Kilik Pass. The settled condition of the country lightened his work to a great extent, and he reported that it would be practicable to run a series as far as the village of Misgar, but that from there it would be advisable to follow the general line of the Khūnjerab Valley and Kharchanai Pass. He also advised the use of a smaller instrument in place of the 12-in., which had been used

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as far as Gilgit. This latter advice was followed and a 6-in. micrometer theodolite was used for the subsequent triangulation.

During the summer of 1911, the Russian triangulation had been extended to the Russian frontier, and two stations in the neighbourhood of Beyik and Taghramansu, on the Russo-Chinese border, had been fixed. But, owing to the results of Bell's reconnaissance, the sites of these stations had to be slightly altered.

Lieut. Bell was again in charge of the detachment during the summer of 1912, and it seemed possible that the end of the season would see the completion of the link. The detachment arrived in Gilgit by the 31st May and commenced work soon afterwards. It had been decided to base the connection on a side of the Kashmir Principal Series, which had been completed the year before, in latitude 35° 55′ and longitude 74° 20′. Bell's plans were to go, accompanied by his assistant Mr. McInnes, *viâ* the Pamirs to the end of the Russian triangulation, arranging *en route* the work in the upper reaches of the Hunza Valley, and selecting the actual route north of Misgar. During this reconnaissance, he decided that the Khūnjerab Mountains would be impracticable for accurate work, and that the Kilik would probably afford the only suitable route.

In the meanwhile, a second detachment under Mr. Collins was to work up from the neighbourhood of Gilgit.

The year was a disastrous one for the Survey. From the very first, bad luck dogged the expedition. Early in June, the various detachments left Gilgit, but the weather was very unfavourable, and while on Yashochish Hill-Station, in the Great Himalaya Range, the camp of Mr. Abdul Hai was wrecked by lightning; his servant was killed, and his recorder was severely burnt, while he himself received a bad shock, which necessitated his return to Gilgit. This district is notoriously bad for electrical disturbances, and very different from the regions of the Karakoram, which, judging from the observations made by the Duke of the Abruzzi, are very free from storms. Collins carried the triangulation on from Gilgit towards Hunza, but on the 28th July, he had to take over charge of the detachment owing to Bell's death.

The latter, with McInnes, had crossed to the Taghdumbash Pamir McInnes was detailed to reconnoitre towards the Kilik Pass, and Bell proceeded to the Russian stations on either side of the Beyik Pass, on the Russo-Chinese frontier, meeting the Russian party under Colonel Tcheikine on the pass. On his return journey he completed the observations at three stations, and ascended a fourth, but here he found some difficulty in observing to one of his stations (Lup Gaz). He therefore decided to move his camp to this station, with a view to finding out if the stations were intervisible. He had not been very fit for the last few days, and had been over-exerting himself. On the 19th July, when in camp on Lup Gaz Hill-Station

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he awoke in very great pain, and becoming no better, he was carried down to his base camp in the Lup Gaz Jilga. He remained here a few days, and on the morning of the 24th, sent a note to McInnes asking him to come and take over the observations. McInnes received this note on the following morning at his camp near the Kilik Pass and at once proceeded to Lup Gaz. The same night Bell passed away. It is hardly necessary to add after what has been written above, that the ultimate success of the work, was to a large extent due to Harry Bell's untiring efforts. He never ceased to think of the link, and during his last interview with McInnes, he urged on him the importance of getting on with the work. On his death, I personally lost my dearest friend and I had known him intimately for many years; he was a daring mountaineer, and absolutely fearless, and his loss to the Service and to geography is greatly to be regretted.

This disaster delayed the work very considerably, and by the end of the season, a short late one for this part of the world, the triangulation from Gilgit had only been completed to a point some little way below Hunza. McInnes reconnoitred the Pamir work, but the reconnaissance in the Hunza Gorge showed that a departure would have to be made near Misgar, in order to obtain suitable figures. As the crow flies, there remained about 70 or 80 miles to be traversed with triangulation, but the actual length of the work would have to be half as much again. Of this about two-thirds was more or less reconnoitred.

During the winter of 1912–13, the question of this connection was again discussed at the International Geodetic Conference at Hamburg, and another Resolution was passed expressing the hope that the connection would be carried on again in 1913. On my return from three months' leave in Switzerland in February, I was given charge of the detachment to complete the work. Before going on leave, I had asked for the services of a member of the Indian Medical Service who would be able to assist in such subjects as Geology and Botany, and before leaving Dehra Dun, I had the pleasure of hearing that Lieut. R. W. G. Hingston, I.M.S., with whom I was acquainted, had been appointed. The results of his work are included in this report. Almost the entire collection of fauna was made by him, many of the rock specimens and plants from the Pamir itself were collected by him; the completeness with which the observations were taken to cirrus clouds for the Meteorological Survey of India, and the hæmatological investigation are entirely due to his energy. In addition to this work, he very largely assisted me with the photographic survey, both by taking photographs, and by helping with with the development in the evenings; and when my recorder went sick, Hingston undertook the work of recording. Since returning he has been engaged on the classification of his zoological collection, during his spare time.

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The last week of February and the whole of March were spent in making preparations for the expedition, and in arranging the additional work to be done. The whole programme had to be thought out, and any difficulties that could be foreseen guarded against, for when once on the way, every day, almost every hour, was valuable, and we could afford to take no chances. The question of rations had to be carefully considered, as the country in which we were to work, produces no crops of any kind, nor does it contain any villages. Transport had to be prearranged, for the whole journey from Rawal Pindi to Gilgit, and a preliminary estimate worked out as to the number of coolies required. Instruments and kit had to be weighed and packed into loads not heavier than 60 lbs., suitable to the many and varied forms of transport. In connection with this, during the march up the road, there were a few loads that were somewhat heavier; in particular, the memorial stone to be erected in Gilgit to Harry Bell, which had come with me from England; but in every case where a coolie had the choice of carrying the excess load, plus a slightly increased wage, or of taking turns with a lightly laden coolie, he preferred the former. The three large cases of tea taken up for the coolies' consumption, came also under this category.

As regards our own rations, we did ourselves well. Cases were made self-contained, so that only one case was open at a time. The great thing to guard against was loss of appetite and consequent loss of energy, and it was hoped that a varied diet would contribute towards this end. The arrangement was as follows:—Boxes labelled A/1, A/2, B/1, B/2, etc., were for ordinary consumption; those marked C and D, for cooking and special occasions, respectively. All the "As" and "Bs" were in wooden cases, with the exception of A/1, which was packed in a padlocked yakdan. All the "As" were similar and all the "Bs," but the "As" differed slightly from the "Bs." The contents of both types were estimated to last three men for a fortnight, two men for three weeks, or one man for six weeks. When "A/1" was finished, "B/1" case was opened, and its contents turned into the yakdan; when this was again empty, or, more strictly speaking, on the regulation date, "A/2" was opened and its contents turned into the yakdan; and so on. This system worked excellently.

Each officer took a 40 or 80-lb. double-fly tent, and in addition, the Pamir detachment took two single-fly 16-lb. Whymper tents. These latter should be made of very fine material, a superior Willesden canvas, but the one made in Srinagar to the pattern used by the Duke of the Abruzzi, was not a success, and one is led to the conclusion that this special type of tent should only be purchased from the best makers at home. My own Whymper tent, which first saw service with the Duke of the Abruzzi in 1909, completed its fifth year of constant use in the hills on the Pamirs, and is still

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quite serviceable. In our high camps Hingston and I shared my 16-lb. Whymper tent and slept in sleeping bags on the ground; while the other was shared by the men. Khalassies and Gurkhas were supplied with 10-ft. by 8-ft. single-fly tents, generally four men to each. Coolies were given a tent, known as "the wigwam," 20 to 25 men in each. This consists of a light central umbrella-shaped structure, supporting a form of bell-tent. The height of the central part is about 4 ft.; I once, and only once, inspected one of these after a cold night, and ascertained that 25 Balti coolies find no difficulty in maintaining a good temperature. This tent is exactly the right type for coolies; it was, I believe, invented by an officer in the 5th Gurkhas.

Khalassies were clothed on the scale known in the Survey of India, as the "Arctic." It consists of

1 Balaclava cap.
1 warm coat.
1 pair warm *paijamas*.
1 woollen jersey.
1 warm puggrie.
1 pair puttees.
1 pair woollen gloves.
2 pair woollen socks.
4 thick blankets.
1 pair boots.

In addition, a waterproof sheet was issued with each tent. A point which I consider of great importance, is the personal fitting of the boots; and Hingston and I saw to this ourselves. Each man was given a pair of boots one size larger than his ordinary size, to allow him to wear two pairs of socks within each boot, so that his circulation would not be impeded. No cases of frostbite occurred amongst the men so booted. The whole of this warm clothing was purchased from the Supply Depôt, Rawal Pindi, and wore very well. As regards my own footgear, I found that the most comfortable for snow and rockwork was the ordinary ski-ing boot packed with at least two pairs of ski or goat-hair socks.

The date fixed for departure from Dehra Dun was the 10th April, and on this day everything was as ready as possible, and the detachment left by train for Rawal Pindi. Besides Hingston and myself, the detachment consisted of two assistants, Messrs. V. D. B. Collins and C. S. McInnes, who were each to have charge of sections of the work. Collins was to work up from the neighbourhood of Hunza, my own detachment was to work back from the Russian end, while McInnes was to reconnoitre the country in between, and observe there if he had time.

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During the season the Link was completed, and now the triangulation, commenced over a century ago by the originator of the Survey of India, has reached and crossed the most northerly point of the Indian Empire. The Russian work in Asia has come down and joined on with this, and the whole series is practically complete from the ninth parallel on the south to the sixtieth parallel on the north.

I should like to take this opportunity of thanking all those who rendered assistance to the expedition. I am extremely indebted to Sir George Macartney, K.C.I.E., His Britannic Majesty's Consul-General at Kashgar, through whose kindness and personal influence any political difficulties on the Pamirs were avoided; to the Taotai of Kashgar and Amban of Tashkurghān who sent representatives to the Sarikōli Begs, instructing them to help us in every possible way; and to the latter for their invariable kindness and hospitality.

We met with the greatest assistance from the Hon. Stuart Fraser, C.S.I., C.I.E., Resident in Kashmir, and from Major A. D. Macpherson, Political Agent at Gilgit, who smoothed out our way to a large extent, and it will be impossible for us ever to forget the generous hospitality extended always to us at Gilgit—hospitality which has been recorded by every traveller in these parts, but which could never have surpassed that which we encountered.

It is here, too, that I must preface any account of the operations by a grateful reference to my fellow workers; to those indefatigable two Gurkhas of the 5th, Kulbir and Hastabir Rana; to Naik Bulnar Singh, 9th Gurkha Rifles, and his hard-working signallers; to my guide, Abdulla; and lastly to the long-suffering and much-maligned coolies, whose admirable qualities were never marred by those mutinous tendencies which may be expected from any followers if treated with a total lack of consideration and tact.

In connection with the writing of this report, Capt. Hingston and I are indebted to Mr. H. H. Hayden, C.I.E., Director of the Geological Survey of India, and to Mr. J. Coggin Brown, M.SC., of the same department, for their interest and for the classification of the rocks brought back by the expedition, which are now in their museum at Calcutta; to Dr. Gilbert Walker, C.S.I., F.R.S., Director-General of Observatories, and Mr. W. A. Harwood, M.SC., Assistant Director, Aerological Observatory, Agra; to Mr. M. S. Ramaswami, M.A., Royal Botanic Gardens, Sibpur, Calcutta, for his classification of the flora and to Mr. R. N. Parker, Imperial Forest Survey, for his arrangement of this section; * to Mr. N. D. Riley, of the Insect Department, British Museum, to Mr. W. M. Tattersall, of the Manchester Museum, and to Mr. N. B. Kinnear, of the Bombay Natural

* Since writing the above, and before the final publication of this report, Mr. Ramaswami has rearranged the whole of the chapter on the Pamir flora, and has written an introduction to his classification.

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History Society, for assistance in classifying a few species of the fauna collected; and lastly to Major H. Wood, R.E., Survey of India, for many suggestions and corrections.

With reference to the triangulation, I would add my conviction that the final success of the British contribution to the link would never have been so fully attained but for the devotion of my friend Harry Bell. He it was who reduced the possibilities of the connection to the only feasible route across the mountains, and who devotedly gave his life when almost within sight of the completion of the link.

In a recent letter to me, Hingston wrote "I shall always look back on my experience on the Pamirs as one of the most fascinating of my life"; to those of us who were permitted to take a share in the work, the memory of those days spent in the high camps of those vast empty spaces and the recollection of the gigantic scale to which nature has built the mighty barrier wall of this great Empire will always bring back the fascinating days and nights spent among the silent Lords of the Mist-Mountains.

Lieut. Mason follows with a chapter on "The Journey to the Pamirs," which we hope to print in the next number of the *Journal*.

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ENGINEERING AND SCIENTIFIC RESEARCH.

By J. A. FLEMING, M.A., D.SC., F.R.S., M.INST.E.E., University Professor of Electrical Engineering in the University College, University of London.

THE following paper read on the 1st May is reproduced by the kind permission of the Society of Engineers (Incorporated), 17, Victoria Street, S.W. :—

There seems to be a very complete agreement that one result of the great war in which we are engaged will be to render absolutely necessary certain reforms in our national systems of education and especially in the attention given to pure and technical scientific knowledge. Hardly anyone disputes the propositions that scientific discovery and research must be brought to bear more fully on our national industries, and must be encouraged to a far greater extent than heretofore in this country; but the moment we go beyond these generalities we find great differences of opinion as to the best mode of giving effect to these desires.

Many scientific men have long and vehemently urged national attention to this matter, but the want of co-ordination between our various learned and technical societies and the strongly conservative element in our older Universities and public schools which resists a break with the past have prevented many useful changes being made.

The Board of Education Scheme.—An important step was, however, taken by the Government through the Board of Education last July in the establishment of a Committee of the Privy Council and the appointment of an Advisory Council to deal with the question of scientific and industrial research as described in a scheme outlined in a White Paper. As this Committee and Council have already come into existence we cannot regard the Scheme as merely a proposal to be discussed. We must accept it in a sense as an accomplished fact, but one in which the details may, we hope, be considered as open to modifications.

Since any such Government control over scientific research is bound to have a great influence in time on the direction of scientific work and its applications, it appears most desirable to gather views upon this scheme even after its inception, from those who are concerned with one of the most scientific of these industries, viz., engineering in all its branches

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It is estimated that the capital invested in Great Britain at present in plant and materials in the two branches of mechanical and electrical engineering is probably not less than £1,000,000,000. When we bear in mind the manner in which a single perfected improvement or invention can revolutionize a whole industry it needs no further argument to prove the necessity for careful attention to the progress of scientific research in connection with it. Hence it seems extremely important that engineers should have the opportunity of discussing schemes proposed, or already launched for dealing with industrial and scientific research lest steps should be taken to give permanent form to proposals without sufficient consultation with those who will most be affected thereby.

It is a very widely held opinion that all that is required to effect reforms are Acts of Parliament, the formation of Committees, or the issue of regulations. Many instances could, however, be called to mind of legislation undertaken with all apparent care, the effect of which has been exactly the opposite of that intended. Electrical engineers will no doubt remember an Act of 1882, somewhat ironically termed "An Act to facilitate Electric Lighting," which was passed almost coincidently with the completed invention of the incandescent electric lamp, the immediate consequence of which was to throttle effectively this nascent industry in Great Britain for six years.

Necessary Improvements and Reforms.—In the particular matter under discussion we have been compelled to recognize the manner in which important industries have died out or never thriven in this country in consequence of our neglect of scientific education and research. It is equally important to realize that we cannot undo the effect of this neglect by a wave of the wand, but that reforms to be useful must be very deep and very thorough and begin at the top and at the bottom in our systems of national education. Whilst we cannot hope to reach anything like unanimity on a subject so complex as the means of imparting or creating knowledge, it is of the utmost moment that engineers should carefully consider the various proposals made for reforms, so as to bring to bear their practical experience on it and not permit schemes to advance too far which are the product merely of academic or political thought.

We have to consider then—

(i.). The improvements in the training of men who will become engineers.

(ii.). The best means by which scientific knowledge can be brought to bear on the problems of engineering.

(iii.). The scientific method in relation to the business side of engineering.

The enormous destruction during the War of the products of the engineer's shop and office will call for reconstruction, and offer a

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vast field for engineering work on its conclusion. We have to see to it that as much as possible of this work falls into the hands of the United Nations which form the British Empire.

This work will make a call for men trained both in the scientific and practical side of engineering and also for others proficient in the business aspects of it.

It is unquestionable that the success of the Germans in the commercial field is in part due to their system of national education, which prepares every man for some vocation and does it thoroughly. We are by no means desirous of copying it in its entirety as it possesses grave defects on its ethical side and in its extreme cultivation of materialism in its worst aspects. Nevertheless, we can usefully draw some lessons from it.

Our own educational systems from bottom to top are too bookish, too much devoted to the cultivation of memory and words, and not sufficiently leavened by a real knowledge of the facts of nature and power to draw true inferences from observations. The success of the Montessori system of training young children and of the Baden Powell Boy Scout movement in imparting self-directing power and vivid interest in learning about things, shows what can be done on right lines.

We have to bring the same principles to bear on all other departments of education. One barrier in the way of our industrial progress has been the imperfect scientific training of foremen, managers, and young heads of departments in many engineering works. The young men who are brought in to fill directing positions have generally received the usual public or middle-class school education with its entirely insufficient attention to scientific subjects. Even when this has been supplemented by a course at a technical college the time at the latter has been so much taken up with learning things which ought to have been learnt at school that the opportunity of acquiring advanced scientific knowledge or real power of independent investigation has been very much curtailed. Hence when once immersed in business it has been impossible for them to keep up with scientific advances, and they can at most copy what they see others do. We have to produce more men who can do new things, and not merely know about old ones.

Until this state of affairs is remedied it is perfectly futile for Great Britain to hope to gain pre-eminence over Germany in scientific industries. The advantages which we have in greater originality of mind and better workmanship are neutralized to a large extent by the want of a sufficiently thorough and broad scientific education to enable us to see the practical value of, and work out exhaustively, and especially with reference to trade purposes, the openings given by scientific discoveries. It is the want of this sufficiently thorough scientific education which accounts for the limited faith of many

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employers and capitalists in scientific research and also for the inability of the practical worker to take advantage of, or see the meaning of facts which present themselves to him in his every-day work.

One of the educational reforms which seems most necessary is the compulsory attendance of lads after leaving the Board School at a technical continuation school. Assuming he leaves at 14 or 15 and is taken on at an engineering works it should not be optional whether he attends a continuation technical school. He should be compelled to do it until he is 17 or 18 years old, as in Germany. This continued education should not be merely a handicraft training but should be a careful instruction by practical men who are or have been engineers; in mechanical drawing, graphics, mechanics, physics, chemistry, metallurgy, electrotechnics and machine construction. The attendance should not be allowed to become irregular and the certificates of proficiency should have an immediate effect on the lad's prospects of advancement.

In the case of young men of higher social rank who have been to public schools I am very strongly of opinion that the practical experience in the shops and drawing office should not be deferred entirely until after the college course. The school education should have provided him with a thorough grounding in the elements of chemistry, physics and mathematics, pure and applied, and with a speaking acquaintance with at least one modern language. One year at a University or Technical College should then prepare him to take advantage of some shop experience and after that he should return to the College for a year or perhaps two for the Advanced Laboratory and Designs Work.

The Degree or Diploma Examinations should be made to depend more than they are at present on the results of practical laboratory and drawing office work. My experience is that students who come straight from school to college for three years without break are apt to spend much time in mere amusement and are less serious workers than those who have had some experience in an engineer's shop and then returned to the College.

In order to compress into this time the necessary training our methods and means of instruction must be much improved. It is essential now for every engineer to have a good working acquaintance with certain branches of mathematics. If he has no knowledge whatever of the Calculus or Trigonometry he finds it impossible to read many original papers in the technical journals. In teaching electrotechnics to young engineers I find I have to give much time to imparting elementary mathematical knowledge which ought to have been gained elsewhere. It should, however, be taught by engineers to engineers.

The great thing to guard against on the part of the student is

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premature specialization. He should broaden as much as possible his knowledge of the principles of chemistry, mechanics, physics, mathematics, and metallurgy, and he will then be able, later on, to build up on this foundation. Unless he does lay this foundation he will not be able to follow or assist in improvements. As an illustration of this we may take subjects such as telephony or wireless telegraphy. It is impossible now for anyone to make any really important addition to these subjects who has not a very competent knowledge of physics and some parts of mathematics. The easier problems are worked out and the design of telephonic systems or radiotelegraphic stations has become a matter in which advanced scientific knowledge is an important factor. Then again to make any advance in metallurgy requires a very intimate acquaintance with the chemistry of metals. A lucky accident might give a clue to an improvement, but an observer not sufficiently acquainted with modern chemical principles could not take advantage of it or follow it up.

In the third and fourth year the student will, of course, have given time to learning as much as possible of the methods of testing both mechanical and electrical—as are required in engineering work, the especial object of which is to enable him to deal with the kind of problems which will present themselves in practice.

It is of extreme importance that he should acquire sympathy with and confidence in scientific research to give the data for engineering work.

The Relation of Scientific Research to Engineering.—We turn then to the subject which it is our purpose more particularly to discuss, viz., the relation of scientific research to engineering practice. We may roughly divide this research work into three departments.

There are first the laboratory researches which aim at determining various physical constants of the materials used in engineering which are requisite to give data for design. This knowledge can never be made too accurate or too complete; but the moment one goes to any of the well-known pocket books or tables of engineering data it is astonishing to find the wide gaps in our knowledge. Hence we require abundant provision for re-determining these values for particular samples of new materials to be used in bulk for various purposes.

Then in the second place there are those researches which aid engineering by providing new methods of examination and test of materials or structures. As an instance of this, consider the invaluable aid rendered by what is now called Metallography or the study of the internal structure of metals and alloys by the aid of the microscope. The founder of this branch of investigation was Dr. Sorby of Sheffield, in 1864, who first began the microscopic examina-

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tion of iron and steel. Every engineering student is now familiar with the processes applied and with the immensely important knowledge that has been gathered as to the composition of steels and other alloys by this method.

The great development of pyrometry and high temperature thermometry by the invention and improvement of the thermo-junction and radiation pyrometer and the electrical resistance thermometer, due to the scientific labours of Callendar, Le Chatelier, Holborn, Féry, and many others have provided the engineer with implements of great accuracy for the measurement of high temperatures and made it, in fact, an exact science.

The improvement in the means of testing the mechanical or elastic properties of engineering materials by testing machines is another instance of the same class of research. Of late years the applicances for testing the mechanical properties of materials under repeated stresses, vibrations or blows have become important in giving the dynamic as contrasted with the static stress properties. One of the latest additions to the resources of engineering testing is the very ingenious application of polarized light by Professor E. G. Coker to study the distribution and magnitude of stresses in celluloid models of beams, struts or rivetted plates used in engineering structures. To this class of research we may add such methods as those introduced by Froude for ship designing. Froude invented the method of predetermining the resistance to propulsion of a ship by dragging small scale models of ships' hulls made of paraffin wax through water in an experimental tank. The tractive force required is recorded graphically by a dynamometer. He discovered two very important laws, viz., the law of the "corresponding speeds" and that of the variation of resistance with the length of the ships when moving at corresponding speeds. These laws and methods are of the greatest use in ship design. Is it not possible that the same methods might be applied to determine the resistance of air to moving trains and motor cars, so that experiments with model vehicles would give data for design? It is being applied to the study of aeroplanes and of the problem of flight generally.

Then in the third place we have a type of research which calls for special aptitude and insight, viz., those which lead to the discovery of some new process, material or machine.

An excellent example of this is the discovery made simultaneously by C. M. Hall in America and P. Héroult in France when hardly more than students, which finally rendered the production of metallic aluminium in bulk a commercial success.

The process is founded on the fact that fuzed cryolite dissolves alumina and that if an electric current is passed through the fluid mass at a low voltage it not only keeps it fluid but electrolyzes the

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alumina without affecting the solvent; and since metallic aluminium has a slightly greater density than the electrolyte it falls to the bottom of the cell and is not re-oxidized but can be drawn off in the metallic state.

Further examples of the same important class of researches are given in the production of the various alloy steels, for example, tungsten, vanadium steels, and so on, with their extremely valuable properties. A certain nickel-chromium alloy called nichrome has been found to be of great service in electric heating by providing an inexpensive alloy which does not rapidly oxidize at a bright red heat.

Then we have additional illustrations in the galaxy of inventions which have made the internal combustion engine, aeroplane, steam turbine, wireless telegraphy, the polyphase alternator and asynchronous motor such epoch-making appliances. Whilst the initial ideas in these things were all the outcome of genius their development has required the steady application of the scientific method and the commercial ability to find the means of doing it.

The really important question is, what are the conditions under which we can stimulate this originative power? It is partly due to natural gifts; partly to effective training and partly to the possession of sufficient appliances and means.

Laboratories may, however, be built without number and chairs and scholarships endowed, but unless the right men occupy them very little results.

The true answer to the above question is, I believe, that originality stimulates originality. A really great investigator not only discovers himself but imparts something of his powers to his associates. No one can have worked under Lord Kelvin or studied under Clerk Maxwell without having caught from them some inspiration and some small fragment of their passion for the discovery of new truths and methods of doing it.

Hence we require to establish and strengthen those research institutions such as the Cavendish Laboratory, Cambridge, or the Royal Institution, London, where notable scientific investigators have established schools of research and imparted some of their great powers to students and colleagues. But the subject we are especially discussing is not scientific research in itself but research in relation to engineering.

The engineer requires scientific assistance first in the accurate determination of certain constants and data concerning materials and structures. Also certain very accurate gauges and measuring tools.

The work of furnishing these must be beyond suspicion in accuracy and authoritative in effect. Hence it can only be done in a national

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institution like the National Physical Laboratory.* The Engineering Standards Committee of the various engineering institutions has, however, rendered invaluable service by settling specifications for materials and sizes to be used in engineering and in securing for them general acceptance.

In providing a large mass of accurate scientific data for use in engineering; electrical, mechanical, hydraulic, and illuminating, the National Physical Laboratory has given most valuable service to engineering for the last twenty years. Nevertheless there are matters requiring assistance for which even its present resources are insufficient.

There are problems in connection with electrometallurgy and engineering which await solution for which our present appliances in private or University laboratories are insufficient.

We need in addition to the present resources of the Engineering Department of the National Physical Laboratory an increase in the facilities for metallurgical research work on a large scale, such as that conducted with valuable results in University College, Sheffield. Such a laboratory should be provided with full-size smelting and refining furnaces by coke, gas, and electric heating and with testing machines capable of dealing with test objects of commercial size even full-sized bridge members.

The engineering laboratories of some London colleges, such as University College, should have their accommodation and appliances largely increased. It would be of great advantage if these laboratories were so equipped as to specialize in certain lines of research and brought into closer contact with the problems requiring solution in connection with actual engineering work.

* The writer may, perhaps, be permitted to recall to mind that in November, 1885, he read a Paper to the *Society of Telegraph Engineers and Electricians* afterwards called *The Institution of Electrical Engineers* on "The Necessity for a National Standardizing Laboratory for Electrical Instruments." In the discussion on that paper about eighteen speakers were unanimous in approving the proposals in it. The Society appointed a Committee to further the suggestion, but want of funds prevented anything being done at the time. The writer spent much time in the next two years in working out the details of such a laboratory with the late Major P. Cardew, R.E. On June 19th, 1889, a deputation was received by the then President of the Board of Trade representing the Institute of Electrical Engineers and the London Chamber of Commerce urging the Establishment of a Board of Trade Standardizing Laboratory. This was done in the following year. In 1891 and 1892 Sir Oliver Lodge brought to the notice of the British Association the necessity for a National Physical Laboratory, and a year or two later the late Sir Douglas Galton described in a Presidential address the recently established *Reichsanstalt* in Berlin or State Physical Laboratory. Shortly afterwards our own National Physical Laboratory was established very much on the lines indicated in the writer's paper of 1885.

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Much of the work carried out would then be of a highly confidential character, and might have to remain unpublished but be communicated privately to firms and corporations concerned with the subjects of the investigation.

Industrial Co-operative Research.—In Germany much of the technical research work is carried out privately by private associations of the trades concerned. In Great Britain manufacturers in the same trade are far too prone to regard one another as rivals, whereas in the future they will have to stand much more shoulder to shoulder against their common and German antagonists who will be united against them.

Hence in many matters it would pay British firms in the same business to promote scientific research in common on certain problems of manufacture, subscribing together the funds to undertake it either at a national technical laboratory or at some technical college or university which may be provided with the proper equipment. Such information when obtained would then only be communicated to the members of the association or union.

Then, again, the same principle of common action might be brought to bear upon the collection of information as to what is being done in certain branches of manufacture; the establishment in fact of an information bureau common to certain firms or manufacturers. There are, as everyone knows, already in operation many powerful and important trade associations, such as the British Electrical and Allied Manufacturers Association (B.E.A.M.A.), and many other kindred organizations which are doing and could extend this work with great effect.

It is certain that, as a rule, British technical firms do not expend anything like the same labour or money over their intelligence departments as German firms. The latter gather in from all countries every scrap of information which can assist them, both from scientific and technical papers and patent specifications. This is carefully digested and classified so that they are able to keep careful watch on progress in their own subject. The smallest valuable novelty is then carefully tested in practice.

The first direction in which our advances should be made is in improving the means for obtaining this early information on possible improvements and advances. In gathering in and bringing to early notice technical improvements greater assistance might, perhaps, be rendered by our technical papers and the proceedings of our technical institutions.

The field of knowledge is now so vast and technical literature so voluminous that it is becoming increasingly difficult for the busy engineer, whose day is occupied with settling contracts, specifications or routine work in an office or factory, to keep himself apprised of

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new departures in his own special work, even with the aid of all our ably conducted technical journals.

We need to improve in every way our means of classifying and notifying technical and scientific novelties and patent applications so that it may become more easy to keep abreast of progress. But when all this is done we may be as far as ever from making those discoveries and inventions which have value in commercial world.

If we look carefully at the history of successful invention we see that it always involves three things: first, a new idea or fortunate observation; secondly, the persistent following out of this idea to its logical issue by persevering work. The first step is always a stroke of genius, the second stage involves generally skilled assistance by persons of competent technical training. But there is a third stage, viz., the translation of the process or discovery into a commercial manufacture. This stage requires capital outlay and often large preliminary expenditure before any return can be obtained, but also it involves and necessitates high ability in applying the scientific method to the commercial problem. The public do not understand this. They mostly think that an invention leaps full grown from the head of an inventor like "Minerva from the head of Jove."

Everyone has known cases of scientific manufactures or industries which have been nearly brought to ruin under one management and rescued and reconstructed by another. Hence no amount of official organization of scientific research will necessarily produce successful results unless the men with right judgment and initiative are brought to the front.

The Position of the Engineering Institutions in Relation to Schemes for assisting Industrial Research.—The point which requires consideration is whether the scheme promoted by the Board of Education will meet these requirements of technology and manufacture and especially of engineering. For one thing it is much to be desired that the Advisory Council should have on it members who represent the constructive and manufacturing side of engineering in various branches. As at present constituted it is chiefly representative of eminence in pure scientific knowledge. It is satisfactory to find, from the latest report of its decisions and work that as regards assistance given to industrial research, its aid will be given through the intermediation of the established professional and technical institutions or societies because they embody in their membership the knowledge of the most necessary requirements in the way of such research.

A further reason for it is because many important problems which need attention are very large ones and will require the assistance of many experienced men. Such problems are the conservation and more economical use of our national coal supply; the universal

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adoption of gas or of electric heating in place of the wasteful combustion of raw coal in domestic fireplaces, the electrical transmission of power from coal fields to great cities, are examples. The coal question in its various aspects is especially important. Of all European coalfields, Germany has the largest known reserves, though of inferior quality. There are three great coal-bearing districts in Germany, viz., the lower Rhine and Westphalian basin, Silesia, and the Rhenish district near Saarbrücken and Aix-la-Chapelle. The life of these fields has been estimated at 2,000, 1,200, and 4,000 years respectively, whereas the figures given by the Royal Commission on Coal Supplies in Great Britain fixed the life of ours at about 200 years. We have, however, the advantage of superior quality of material. Nevertheless we must bring, at once, the highest scientific knowledge to bear upon the subject of our more scientific coal consumption and use. These are matters quite beyond any individual or small committees to deal with, they demand the conjoint consideration of many minds. Hence it is to be hoped that the principal engineering institutions will unite in a strong request to the Government, if they have not already done so, to place representative engineers upon the Advisory Council and also that in the disbursement of funds allocated to the assistance of industrial research, these institutions, as bodies, shall be to a considerable extent the avenues through which it is dispensed.

The present policy of the Government and of the Board of Education seems to be the creation of fresh committees and boards whilst setting on one side the existing learned and technical institutions. The latter are corporate bodies which include in their membership all those who have special knowledge and eminence in their various subjects.

Thus we are promised a plethora of new committees on various subjects which already fall within the scope of the operations of old-established and strong professional societies like the various engineering institutions of civil, mechanical and electrical engineers, and the Iron and Steel Institute, the Institute of Naval Architects and the Society of Engineers.

Mr. Runciman has, recently, appointed certain committees to report on measures to safeguard the commercial interests of iron, steel and engineering trades and on shipping and shipbuilding. The Advisory Council for Scientific and Industrial Research is also appointing standing committees to deal with mining and metallurgy, both non-metallic and metallic mining and non-ferrous and ferrous metallurgy. Also an engineering committee is promised as well. Furthermore, the Royal Society recently called a conference of about twenty-five of the chief scientific and technical societies and it was decided to form a board to advise the Government on any branch of scientific inquiry which may be brought before it.

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The result of all this must be to diminish rather than increase the very organization and co-ordination required.

We are told that "in the multitude of counsellors there is safety," but it may seriously be doubted whether the same can be said of a multitude of committees unless very carefully organized and correlated. The existing scientific and professional societies if properly organized would supply all that is required. These engineering institutions and societies should take a leading part in guiding the fortunes of the industries they represent and not be reduced to the level of mere paper reading or discussion societies.

The head of the group concerned with pure scientific research should be the Royal Society acting not through a few, but all of its Fellows. At the head of the technical research an organized body selected from the professional and technical societies. At present, the Government prefer to ignore the existing societies and create fresh bodies of their own selection. The result will be to weaken these existing institutions and societies.

It is essential to guard against the bureaucratization of science, and the safest and most simple method of avoiding this would be to make the great technical and professional institutions the means of advising upon the most important steps to be taken in aiding technology. Suggestions have been put forward for the creation of a Ministry of Science. It is difficult to see how any such step will assist matters at present, whilst on the other hand it might be the beginning of a system of bureaucratic control which would involve a cumbersome and expensive machinery with much inertia and delay in giving assistance to genuine research.

We have first to create a great change in the attitude of the public mind towards scientific knowledge and research and develop the conviction that until it is regarded as a most serious pursuit we shall fail to make any firm advances towards victory in industrial war.

The Scientific Organization of the Business Side of Engineering.—Then we must glance in the last place at the applications of the scientific method to the commercial side of engineering.

No one who has studied, even casually, the German methods can fail to admit they have realized fully in commercial matters the truth that union is strength. Whilst British firms are regarding one another as competitors and greatly afraid to exchange information, their German rivals have adopted every possible means to weld together all portions of their commercial enterprise into one great machine. Our ideal has been largely individualism and competition, theirs has been organization and co-operation. The German commercial system is essentially militant in nature and organization. It is all part and parcel of the plan to achieve world conquest at any cost and by every means.

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Our post-war policy cannot, therefore, be simply defensive. No tariff wall can be built so high, no boycott of German goods so thorough, as to defend our position in the absence of a positive and vigorous policy of attack.

Hence the first condition of success must be association and combination, and the second the scientific method in all things.

The first principle of scientific investigation is to collect the facts and to draw deductions only by the light of full knowledge.

The inference is that our information about foreign markets must be greatly increased. This means that our Consular Reports must be improved, that foreign agencies must be staffed with men who have the necessary linguistic and scientific accomplishments, and that the study of foreign markets and of the nature of the foreign demand for goods shall be made a scientific study.

In Germany, besides the assistance of their complete Consular Reports and the help of carefully devised legislation and low export rates on railways, there are special institutes founded in connection with the Universities for the scientific study of the problem of international commerce. Private firms also associate themselves into export societies. Thus manufacturers, shippers and financialists interested, say, in the Russian or South American trade, will club together to obtain information, support agents, and obtain facilities. Steps will probably be taken for a long time to come to prevent the re-establishment in Great Britain of that immense system of organized commercial espionage by Germans who took situations and appointments of all kinds here at reduced salaries, because they were partly supported by subsidies, to collect information and transmit it in weekly reports to their real employers in Germany.

In the main, however, we have to rely on bringing to bear scientific knowledge of all kinds upon the manufacture and distribution of goods and obtaining foreign markets for the same.

The subsidization of private or national scientific research by Government funds is, therefore, only a small part of the matter.

We need to bring the scientific method of collecting the facts and drawing inferences from them to bear upon all the commercial problems of obtaining the markets and securing custom for the manufactured article. In connection with this part of the subject reference should be made to the valuable series of addresses by Mr. T. C. Elder on behalf of the British Electrical and Allied Manufacturers' Association (see *Electrical Industries*, March 1st, 8th, and 29th), and also to a recent book by Mr. D. N. Dunlop on *British Destiny*, in which the principles of scientific co-operation without destruction of true individualism are well expounded. Some excellent pamphlets on the recapture and expansion of British trade are also published by the International Correspondence Schools, Ltd., of Kingsway, London.

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The importance of a true education in science is that it leads to love of accuracy as to facts, loyalty to scientific truth, unwearying labour in obtaining it, and care in the inferences derived from it. We have to cut ourselves adrift from all the past, its easy, self-satisfied mediocrity, dislike of trouble, and contempt for knowledge.

The first steps in this seem to be large reforms in education, and the second reforms in our system of party government in which the true requirements of our national life are subordinated to the efforts to retain political power in the hands of individuals, clans or parties. The only desirable form of Government is an aristocratic Government in the true and proper meaning of the term, viz., government by the most efficient and the best. The nation will have that Government when it demands it in sufficient earnest.

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Colonel Sir Charles M. Watson, K.C.M.G., C.B., M.A.,
Royal Engineers.

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MEMOIR.

COLONEL SIR C. M. WATSON, K.C.M.G., C.B., M.A., ROYAL ENGINEERS.

CHARLES MOORE WATSON was the second son of William Watson, civil engineer (of whom there is a memoir in the *Proceedings of the Institution of Civil Engineers*, Vol. LXXV.), and of Sarah, daughter of the Rev. Moore Morgan, rector of Dunlavin, co. Wicklow. He was born in Dublin on 10th July, 1844, and was educated at Dr. Fleury's school in Lower Leeson Street. At the age of 17 he entered Trinity College, Dublin, and was placed in the first division. He obtained honours in the term examinations of 1862, but his undergraduate course was interrupted by his wish to be a soldier. In July, 1863, he passed for Woolwich at the head of his batch, and he was still at the head of it when he left the Academy in December, 1865, receiving the Pollock Medal. He then took his degree as B.A. at Dublin University, proceeding M.A. in June, 1869.

He was commissioned as lieutenant, R.E., on 17th April, 1866, and after spending two years at Chatham was sent to Cork Harbour, where he was placed in charge of the new defence works at Carlisle Fort. In October, 1871, he returned to Chatham, being posted to No. 4 Company, which was converted into a submarine-mining company. He took part in experiments in submarine mining and ballooning, and worked out details of equipment for the Ashantee Expedition. At the beginning of 1874 he was placed in charge of railways in Woolwich Arsenal and Dockyard, but was invited soon afterwards by Colonel C. G. Gordon to join him in the Southern Sudan for survey work. He went out in July, and was employed on the survey of the White Nile from Khartoum to Rageef along with Lieut. W. H. Chippindall, R.E.

Their traverse survey of the White Nile was printed in the *Journal of the Royal Geographical Society* for 1876, and was praised by Gordon. But the work was extremely trying to men not used to hot climates and both of them fell ill. In February, 1875, Watson was sent home, Gordon writing to the D.A.G., R.E. :—" I have every reason to be satisfied with Lieut. Watson ; he has been zealous and most painstaking in his surveys, and it is much to my regret he leaves me ; but, however much he may have wished to stay, I considered that it was not my duty to let him sacrifice his life in continuing here." For the remaining ten years of Gordon's life he kept up correspondence with Watson, and his letters were full and frank.

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On his return to England Watson had six months' sick leave, and was then employed at the War Office in connection with the defence of London. In March, 1877, he was made Secretary of the Siege Operations Committee. He compiled an *English-Arabic Vocabulary for the Army and Navy*, which was issued officially in 1878. He was promoted captain on 25th December in that year. Two months before this he had become A.D.C. to the Inspector-General of Fortifications, Sir Lintorn Simmons. There had been talk of his rejoining Gordon, who was then at Khartoum as Governor-General of the Sudan, but Gordon regarded his own stay there as too uncertain. He wrote:—"I am somewhat relieved that you have taken the A.D.C., though it is a loss to me. This country is a pest house, the people have been dying like flies, and my belief is that Europeans cannot live here. You are sure to get on, and I feel certain you will have a fine career. These countries are not for such men as you are, they are more for the brigand class."

In the spring of 1880 Watson went to the India Office to assist in the reorganization of the India Store Department. On 11th May he was married at Montrose to Geneviève, daughter of the Rev. Russell S. Cook, and granddaughter of Dr. César H. A. Malan of Geneva. His wife was a true helpmate to him for the rest of his life, sharing his interests and labours. She was with him in Egypt and at Suakin, and accompanied him in his journeys, which extended, not only to all parts of Europe, but to Palestine, South Africa, and America. They spent on an average two months of the year abroad.

In December, 1880, he passed the final examination of the Staff College without going through the course at the College. In August, 1882, he was ordered to Egypt, for service in the Intelligence Department of the Expeditionary Force, being graded as D.A.Q.M.G. He was present at the actions at Tel-el-Mahuta and Kassassin, and at the Battle of Tel-el-Kebir. After the battle Sir Drury Lowe, who commanded the Cavalry Division, was told to advance upon Cairo with the utmost rapidity, "to save it if possible from the destruction intended by Arabi Pasha." Watson was Intelligence Officer of the division, and he was directed to guide the right column, consisting of Indian cavalry and mounted infantry. The column halted that night at Belbeis, 30 miles from Cairo, and was joined there by the 4th Dragoon Guards. Without waiting for the rest of the Heavy Brigade and the Horse Artillery, which had been delayed on the march, Sir Drury Lowe advanced early on 14th September with a force of 1,200 men. At the Abbasiyeh Barracks, 2 miles N.E. of Cairo, there was an Egyptian force of 10,000 men of all arms, which surrendered unconditionally.

The Governor of Cairo, the Chief of Police, and the Commandant of the Citadel were sent for, and were informed that the Citadel must be surrendered that evening. The Governor begged that

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British troops should not be sent into the city lest there should be disturbance ; but there was greater risk of mischief by evil-disposed persons if the Citadel was not occupied at once. As Watson knew Cairo, it was eventually decided that he should be entrusted with this delicate task, which was at first assigned to Colonel Herbert Stewart. He was to enter the city after dark with 150 men, cavalry and mounted infantry, and to get possession of the Citadel and of the fort on Mokattam Heights which commanded it.

The story of the enterprise has been told by Watson himself in *Blackwood's Magazine* (March, 1911). He was accompanied by four Egyptian officers, one of whom was an Engineer who had been sent by Arabi to make arrangements for the defence of the Abbasiyeh Barracks. Guided by this Engineer, the British entered the city by a small gate just under the Citadel, and made their way to the main gate of the Citadel where there was a strong guard. Watson sent for the Commandant and called upon him to withdraw his troops and hand over the keys. After much delay and hesitation this was done. The Egyptian troops, to the number of some 6,000, "fell in by companies and marched off as if they were quite accustomed to being roused up in the middle of the night and turned out by foreign troops. . . . For more than two hours the stream of Egyptians came out through the middle gate, and it was midnight before the last stragglers went down the hill." Watson took care, while this was going on, to keep his own scanty numbers out of view. Picking out an officer who was leaving the Citadel, he sent him to the Mokattam Fort, and in two hours the officer brought back the keys of it, having turned out the garrison and locked the gate.

Handing over the command in the Citadel to the next senior officer, in accordance with his instructions, Watson returned to Abbasiyeh to make his report ; and on his way there he rode through the city from end to end, accompanied by two Egyptian officers, so that he was able to say that Cairo was peaceful. Lowe's rapid advance, followed by this bold stroke, had saved the city from the fate of Alexandria. Watson was given a brevet majority and the Order of the Medjidieh (4th Class), as well as the medal and bronze star.

He returned to England in October, but in January, 1883, he went back to Egypt at the invitation of Sir Evelyn Wood, to assist in the reorganization of the Egyptian Army. He was appointed Surveyor-General with the rank of colonel. In August, 1884, when Sir Evelyn Wood took charge of the lines of communication of the Nile Expedition, Watson was appointed Acting Sirdar and Chief of the Sudan Department. This kept him at Cairo, and though he was recommended for a brevet lieutenant-colonelcy he did not get it. In April, 1885, he received the Order of the Osmanieh (3rd Class), and in July he was made pasha in the Egyptian Army.

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In the spring of 1886 he was appointed Governor-General of the Red Sea Littoral in succession to Sir Charles Warren. He took up his duties at Suakin on 3rd May. His younger brother, Capt. A. J. Watson, who was afterwards killed before Colesberg when commanding the 1st Suffolks, was his assistant Military Secretary. Osman Digna had left the neighbourhood of Suakin, and most of the tribes were tired of war. Watson did his best to conciliate them, and promised that markets should be opened for them as soon as the country was quiet. Tamai was the chief stronghold of the Mahdists, and a raid on that place made by friendly natives on 12th July met with some success. On 23rd August Watson called a meeting of sheikhs and notables to express their views on the pacification of the Eastern Sudan. Next day he left Suakin for Cairo, and did not return. He was succeeded as Governor-General by Colonel H. H. Kitchener. Tamai was stormed after he had left, but General Sir F. Stephenson reported that much credit was due to him for utilizing the friendly tribes and encouraging them in their friendly dispositions, and that the fights which took place while he was Governor materially assisted in undermining Osman Digna's power. He went home on leave, and in January, 1887, having completed four years' service with the Egyptian Army, he reverted to corps employment. He had been promoted major in the Corps on 17th April, 1886, and he was made C.M.G. for his services in Egypt.

For two years Watson was major of the Training Battalion at Chatham, and he was then put in charge of balloons. In September, 1889, he went to the War Office for duty in connection with the proposed Barrack Loan, and in the spring of 1890 he was sent to Germany to report on German barracks. On 13th May, 1891, he was appointed an Assistant I.G.F. for the work under the Barracks Act, and on 30th April, 1896, he succeeded Colonel H. Locock as Deputy I.G.F. for that work. He held that office till 20th March, 1902, when he was retired on account of age and was made C.B. for his services at the War Office. Thus he was continuously engaged on barrack construction for 12½ years.

In the third volume of the *History of the Corps*, published last year, Watson described very fully what was the work done under the Barracks Act and under the Military Works Acts which followed it. The Barracks Act was intended to make good defects in existing barracks, especially in the large camps; the Military Works Acts of 1897, 1899, and 1901, provided for new buildings made necessary by the increase of the Army and by changes in its distribution. The total expenditure with which Watson had to do was over six millions. In carrying out his duties he made visits of inspection, not only to home stations, but to Malta, Gibraltar, the West Indies, Halifax and the Cape. He might well say, as he did in his paper on *Barrack Policy* criticizing Mr. Arnold Forster's book (*R.E. Journal*, December,

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1907), that the subject was one which he had had considerable opportunity of studying carefully. He was promoted lieutenant-colonel on 1st October, 1892, and colonel on 1st October, 1896.

In his case retirement from the Army did not mean unemployment. He was British delegate at the International Navigation Congress at Düsseldorf in July, 1902, and at similar congresses at Milan in 1905 and St. Petersburg in 1908. In April, 1903, he was appointed Secretary to the Royal Commission for the International Exhibition at St. Louis, and in August he was made British Commissioner-General. This duty took him three times to North America, and involved a continuous stay there of more than a year, in the course of which he visited the Western and Southern States and Canada. His office was no sinecure, but he enjoyed it. He was made K.C.M.G. on 30th June, 1905, in recognition of his services.

His activities were by no means confined to these official functions. He had become a Fellow of the Royal Geographical Society in 1875; he was elected a member of its Council in 1893 and again in 1912. At the meeting of the British Association at Winnipeg in 1909 he was a vice-president of the Engineering Section, and at its meeting at Dundee in 1912 he was president of the Geographical Section. He joined the Council of the London Topographical Society in 1914. In July, 1890, he became a member of the Executive Committee of the Palestine Exploration Fund; in November, 1905, he was elected chairman of it, and remained so till his death. Among his many interests this seems to have stood first, and he grudged no time and pains to it. He wrote many articles on archæological points in the *Quarterly Statement* of the Fund. In 1895 Walter Besant, then secretary of the Fund, wrote an account of the work done by it in the first 30 years of its existence. Last year Watson brought this account up to date, with large additions and alterations, under the title *Fifty Years' Work in the Holy Land: a Record and a Summary.* Three years before he had written *The Story of Jerusalem,* for the *Mediæval Towns* series, with illustrations by Lady Watson. Both of them were members of the Order of St. John, and he became a member of its council in 1906. In 1909 he was made vice-chairman of the Committee of the British Ophthalmic Hospital at Jerusalem, and three years afterwards he became chairman.

He took much interest in weights and measures, and was against the compulsory adoption of the Metric System. He gave a lecture to the Society of Arts on this subject in December, 1906, which won for him the silver medal of the Society. In 1910 he published a little book on *British Weights and Measures, as described in the Laws of England from Anglo-Saxon Times.* He was in request as a lecturer on this and other subjects, such as Egypt and Palestine, the Order of St. John, and old London. He was elected to the Athenæum in 1909, and was also a member of the Junior United Service Club.

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He contributed articles on Jerusalem and the Holy Sepulchre to the last edition of the *Encyclopædia Britannica*, and also a memoir of General Gordon. He wrote the *Life of Major-General Sir Charles Wilson*, published in 1909. His intimate knowledge of Wilson and his surroundings made this a biography of exceptional value, and enabled him to do justice to a man who had been unfairly treated. Lord Cromer's book on *Modern Egypt* moved him to claim *Justice to General Gordon* in the *National Review* (June, 1908).

In 1894 he had attended the Swiss autumn manœuvres as British military representative, and was impressed with the suitability of the Swiss system for our home defence army. In 1909 he published a pamphlet on *Universal Service*, a singularly fair statement of the *pros* and *cons* of voluntary and compulsory enlistment with special reference to our own conditions. He was a member of the National Service League from its formation, but was not satisfied with its programme. Compromise on the score of political expediency was not at all to his taste.

With all his other interests he found time for the concerns of the Corps. He served for many years on the Council of the R.E. Institute, and took an active part in the business at Corps meetings. Quite lately he was elected a trustee of the Widows' Fund. He wrote many valuable articles in the *R.E. Journal*, and memoirs of Sir Lintorn Simmons, Sir John Ardagh, and others. He undertook the laborious task of bringing General Porter's *History of the Corps of Royal Engineers* up to date by a third volume which was published last year.

He was a man whom the Corps can ill spare. Few officers have had such diversified service; yet he always did well, for he was an all-round man adaptable to any job. He had ability, industry, and method, and—as he showed at Cairo—he had courage, coolness, and resource. The end came quickly and he was spared the pains of a long illness. He was occupied as usual up to Monday, the 13th March, when he was sufficiently unwell to see a doctor and go to bed. Bronchitis followed, and on Wednesday, the 15th, he passed away owing to heart failure. He was buried at Putney Vale Cemetery on the 18th, the first part of the service being held at St. Paul's, Knightsbridge (*v. Supplement to the R.E. Journal for April*).

The *Quarterly Statement* of the Palestine Exploration Fund speaks of his death as a calamity:—"During the last 10 years, his able guidance, his wide knowledge, and his personal charm have been invaluable to the Society, and endeared him to all those who in any way shared his work, or were brought into frequent contact with him." There was a good obituary notice of him in the *Times* of 16th March.

E. M. LLOYD.

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REVIEW.

HISTORY OF UNDERGROUND WARFARE.

Being a Review of the book by A. GENEZ, Captain of Engineers, French Army.—(Librarie Militaire Berger Levrault, Paris, Rue Des Beaux-Arts 5–7, 1914. Price 5 francs).

MANY requests having been received that this Review which originally appeared in the *R.E. Journal*, commencing in September, 1914, should be re-published, the first instalment is herewith given.—[EDITOR, *R.E.J.*]

The small importance of the sieges undertaken during the Franco-German War, with the exception of that of Belfort, has had the effect of diverting attention from the use of military mines as an aid in siege warfare. Other causes, such as the advent of heavy shells with large charges, the addition of pontoon bridging to the duties of the Engineers, and the introduction of short service also tended to the neglect of the art of mining. The Siege of Port Arthur, however, has shown that this art is not out of date, and the time seems opportune for reviewing the past in order to recall the glories of underground warfare, to follow its evolution, and to compare the successive characteristics of mining in attack and defence.

This history is divided into four principal periods :—

First period—up to the year 1487 when gunpowder was first employed in mines at the Siege of Serezzanella, near Florence.

Second period—that of breaching by means of mines, from 1487 to the Siege of Candia (1667 to 1669) during which the miner determined to meet his adversary under the glacis, and employ explosives against him.

Third period—from the Siege of Candia to that of Schweidnitz in 1762 where the *globe of compression* of Belidor was first made use of.

Fourth period—from the Siege of Schweidnitz to the present day.

FIRST PERIOD.

The use of mines in the attack is of great antiquity. The Siege of Fidenæ by the Romans in 430 B.C. furnishes a typical example. At this time the only object was to gain a footing unobserved within the defended locality. The employment of mines in defence was probably subsequent to their use in attack, and an old Greek author, writing on the subject of countermines, recommended that when it had been observed that the enemy was driving a mine, a deep ditch should be dug outside the ramparts, having its sides supported by masonry. This was to be filled with dry wood, and when the assailants broke into it,

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the wood was to be set on fire and covered over with earth to force the smoke into the enemy's gallery. Another suggestion was that the introduction of swarms of bees into the mine would cause no little inconvenience to the assailants.

Again, he mentions the Siege of Barca by Amaris, King of Egypt. The defenders were convinced that a mine was being driven under the fortifications, but could not discover on which side. A tinsmith conceived the idea of using a bronze shield as a stethoscope. Applying it methodically to the ground in various places, he soon discovered where the miners were at work. A countermine was then sunk above the besiegers' gallery, and the defenders, having the advantage of the command, soon drove out their assailants.

Polybius gives an account of a breaching mine at the Siege of Pale. Philip III. of Macedonia caused galleries to be excavated up to the walls, with branches under the foundations. The walls were then supported on wooden staging for a length of two arpents (480 ft.). When all was ready the staging was set on fire, with the result that the walls collapsed, forming a practicable breach through which the besiegers rushed and captured the town. It is probable that holes from the galleries were made at intervals outside the walls to allow the smoke to escape and improve the draught.

Philip successfully employed the same system at the Siege of Thebes, but at Apollonia the defenders outwitted him. From inside the walls they drove galleries towards the front, and hung bronze vases in them. The vibration of one of the vases denoted the blows of a pick in a neighbouring mine, the position of which was carefully estimated. Above the supposed position of the mine, a countermine was excavated, in which were collected cauldrons of boiling water and pitch, night soil, and hot sand. During the night shafts were sunk to the mine and the materials thrown into it, killing all the workmen.

During the Milhridatic Wars at the Siege of Thermiscyra countermines were dug over the assailants' mines, and bears, and other wild beasts, also hives of bees, were lowered into them.

Many other instances occur in ancient times, and in the Middle Ages, of the use of mines both in attack and defence. One of the most striking of these is the Siege of Chateau Gaillard by Philip Augustus in 1204. The defenders excavated their countermines too close to the foundations of their wall, with the consequence that it soon fell under the blows of stones hurled from a ballista.

At the Siege of Acre, which fell in 1291, Greek fire was used to set fire to the works. The wooden towers on wheels which the Crusaders had constructed, were set on fire by this substance. Philip Augustus, who was present at that siege, succeeded later in destroying by Greek fire the English fleet which was blockading Dieppe. About the same time Gaubert of Mantes set fire under water to a double stockade which protected the Island of Andelys, after having had fireworks, enclosed in pots of earth, fixed to it by divers.

Cæsar (De Bello Gallico. Vol. VII.) relates that the Gauls at Bourges destroyed his works by mining under them, a labour to which they were accustomed owing to the number of iron mines in the country!

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When the Romans excavated mines the Gauls broke into them, filled them with beams, sharpened, and hardened by fire, with pitch and heavy stones, and thus prevented the miners from approaching the walls.

SECOND PERIOD.

Gunpowder produced a great improvement in weapons of war, but was not used in mines until two and a-half centuries after its invention. The first attempt at modern mining was made in 1487 when the Genoese were attacking the Florentine town of Serazzano. One of their engineers filled his mine with powder instead of with staging and faggots, but as he did not tamp the charge the explosion took effect outwards, and the fortifications were not damaged. A Spanish soldier in the Genoese service, Peter of Navarre, who was at Serazzano and afterwards rejoined the Army of his own country, tried in 1500 to blow down the walls of the Castle of St. George on the Island of Cephalonia. The attempt was not altogether a success, but the breaches which were made led to the surrender of the castle.

About this period, during the quarrels of Louis XII. and Ferdinand II. over the partition of the Kingdom of Naples, the French in the forts surrounding the city of Naples were besieged by the Spaniards. Here Navarre determined to repeat his experiment and blow up the Chateau Neuf. On this occasion he was successful in effecting a practicable breach. The Chateau de L'Œuf was next attacked. Situated on a rocky peninsula almost cut off by the sea and defended on the land side by a deep ditch, the castle could only be approached by sea. Navarre roofed over some boats, and from them opened a gallery which he drove straight under the castle. In this he fired a mine by slow match, the rock was split, and a large portion of the wall of the castle fell. Many of the defenders were killed, the remainder were easily overpowered.

Navarre continued his brilliant career at the Siege of Bologna in 1512, and prepared a mine under the walls. The wall was blown vertically into the air for several feet, but fell again on to its foundations, hardly cracked. So high was it raised that the assailants actually saw beneath it the defending troops drawn up ready to repel their assault. From this failure Navarre learnt not to place his charge exactly under the centre of gravity of the mass to be shattered. That such an event is possible was exemplified in 1795 when the same phenomenon was repeated in blowing up a solidly constructed curtain during the demolition of Fontarabia.

Navarre had by this time achieved such a reputation that the Castle of Milan, which had already withstood several sieges and was considered impregnable, was surrendered with a strong garrison well supplied with food and munitions of war, by Duke Maximilian Sforza, as soon as it was known that Navarre was to conduct the siege.

Countermines were successfully employed at Marseilles in 1524, and at Naples in 1528, and the sieges were abandoned. In 1529 the Turks employed mines against Vienna. These were interrupted for the greater part by the countermines of the besieged, only a few could be fired and the assault was repulsed. The expedient of countermining therefore

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seems to have followed very quickly on Navarre's invention of powder mines

Probably the earliest instance of countermines prepared deliberately in advance occurred at Padua, which was besieged in 1509 by the Emperor Maximilian I. with a mixed army of Germans, Italians, Spaniards and French. This town then belonged to the Republic of Venice, and was exceedingly well organized to resist a siege. The garrison was large, provisions plentiful, and there were two lines of defence, in the interval between which countermines had been prepared. A few exterior works of small importance had been captured when a strong effort was made against one of the bastions. A breach was made by the artillery sufficiently wide for the advance of 1,000 men. Two assaults failed, the third was successful, but scarcely had the last Venetian left the bastion when the mines beneath it were fired. Many distinguished generals were killed, and the Imperial troops were so dismayed that they were rapidly driven from all the works they had already captured.

The moral effect of this event was so great that Maximilian found it impossible to induce any of his troops to hazard a further assault, although he proposed that it should be led by the cream of his troops, the gendarmery of France. Never was such a demand for priests to hear the confessions of those who might be detailed for the assault. The Chevalier Bayard expressed great indignation that noblemen should be expected to risk their lives fighting with bakers, shoemakers, and such riff-raff, and advised that, as there were plenty of German counts, seigneurs, and gentlemen, they should be directed to support the gendarmery, who would willingly show them the way. It is well known how the Chevalier, "sans peur et sans reproche," shuddered at the idea of a bullet, the only weapons worthy of him were spear and sword wielded by gentlemen.

In 1601 an army composed of Spaniards, Germans, Italians, and Belgians, under Marquis Spinola, laid siege to Ostend, which was held by a mixed garrison of Dutch, English, and French. This city had been fortified by William of Orange, who protected it by a girdle of bastions. The attack was directed almost entirely against the front facing Nieuport; on the attackers' left, near the sea, was the Sandhill Bastion, separated by a canal from the Hellemond Bastion, then the West Gate, South-West and Polder Bastions, and on the extreme right the South Bastion. Communication with the sea could not be interrupted, so that the defenders could by this means obtain supplies of all kinds. The Commandant was Colonel Vandernoot, an experienced and clever man.

Every attempt at a general assault failed, and in 1604 recourse was made to a step-by-step advance. To the Germans was entrusted the attack on the Sandhill, to the Spaniards that on the Hellemond, to the Belgians the West Bastion, and to the Italians the Polder and South Bastions.

A lunette called the Green Ravelin covering the Hellemond was first attacked in March, 1604. The earthwork of the salient was demolished by small mines, then called petards, and the salient captured. The work was cut in half by a palisade, to capture which mines had again to be employed. The besieged countermined, and combats took place

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in the galleries, but the besiegers managed to explode their mines, and the place was captured.

Meanwhile the Belgians mined the glacis of the West Bastion, and the explosion of "9 tons of powder" (about 900 lbs.) enabled them to obtain possession of a ravelin which protected the front of the bastion, and to capture its garrison on 18th April. The descent of the ditch was then undertaken, and by 27th May it was possible to reach the escarp. The ditch was fordable, and a hard bottom was made with fascines and hurdles. To save time it was decided not to mine under the ditch, and though a deserter said that the parapet was countermined, six officers and soldiers volunteered to cross the ditch, and make an opening in the escarp. They advanced under a fierce fire from both flanks, but in half an hour the survivors had dug themselves in. A covered way was then made across the ditch, and in eight days' time 40 ft. of mine gallery had been excavated under the parapet. The mine chamber was loaded with "30 tons" (3,000 lbs.) of powder.

Troops were drawn up for the assault, and a few men sent on to the parapet to draw the garrison out over the mine. The result of the discharge was to open a wide breach, but a great deal of the effect acted outwards, and killed or wounded numbers of the assailants. It also opened out the approach to the defenders' fire, and the assaulting troops lost heavily. A counter-attack by 400 men repulsed them to 60 paces from the ditch, their works in the crater were destroyed and their fascines burnt. A parapet 12 ft. high was then constructed to close the breach.

Several days were required by the assailants to regain the escarp, when the besieged themselves fired a mine, thereby disclosing a masked battery constructed behind the parapet, and which commanded the besiegers' approach. However a fresh mine was dug, and was about to be charged when the movements of the defenders seemed to indicate the preparation of a countermine. To make sure if this was the case or not the besiegers sent out a reconnaissance. The defenders thought this the prelude to an explosion, and themselves retired. The besiegers then waited for the discharge of the supposed countermine, and did not dare to return to their works until a spy had ascertained that no countermine existed. Eventually the mine was charged and fired at the end of June. Again the greater effect was produced outwards, and the assailants lost heavily. However the assault was delivered and half the bastion was taken, but another mine was necessary to capture the remainder.

On the besiegers' extreme right the Italians effected the passage of the ditch of the S.W. Bastion, and after several small explosions, each followed by a slight advance, managed to charge and fire a larger mine. The defenders countermined unsuccessfully, and the Italian mine formed a good crater from which they were able to make a further advance. At length the explosion of 2,000 lbs. of powder cleared the way for the final successful assault. But before this occurred the combatants often met below ground, where sanguinary encounters took place in the dark. Occasionally barrels of powder were accidentally fired, burying dead and living, or blowing up indiscriminately any combatants who might happen to be overhead.

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The Spaniards advanced steadily towards the Hellemond, one of their mines uncovering a countermine which was just ready for firing. Another countermine was broken into, but a moment later a second close by was fired, and suffocated more than twenty of their workmen. An hour later the attack fired a mine which killed a number of the defenders, who had been enticed over it by the false alarm of an immediate assault. The capture of the Hellemond, which commanded and flanked the Sandhill, rendered possible the capture of the latter which it was almost impossible to mine as the sand fell in as quickly as it could be removed. It was taken on 13th September.

The besiegers now found themselves confronted by a second enciente. The defenders compared Ostend to ancient Troy, and called their first line New Troy, the second Little Troy. However batteries erected on the outer line soon reduced to silence the guns of the inner lines, which were on a low parapet, commanded by the former. The defenders were not yet discouraged, they fired mines in the space between the two lines and compelled the besiegers to advance with circumspection. When the second line had been captured yet a third appeared. The Germans from the Sandhill were able to penetrate a work defending the old town, which they carried after exploding a mine, and on their right the Spaniards captured a large demilune. The defenders had now lost the key of their position, their communications with the sea were threatened. They capitulated on 20th September, 1604, after three years of siege, and seven months of underground warfare.

Subterranean works thus had an important bearing on the results of this siege, but it is noteworthy that the defenders only used countermines to enable them to reach the attackers' galleries, to fight them there, and do what damage they could by hand. They do not appear to have made any systematic use of gunpowder to destroy at a distance the galleries and mines of their opponents. The explosions of the defence had as object to check the assaulting columns, and to spread panic in their ranks. The way in which they utilized mines to suddenly clear the foreground and unmask batteries trained on the attackers' approaches is also worthy of notice.

In 1654 Arras was besieged by the Spaniards, and affords a good example of the employment of a grand parallel covering the artillery. Approaches from it by zigzag or double sap brought the besiegers to the counterscarp. Fresh batteries were erected on the glacis, and mines carried from them towards the most advanced work, which was not revetted, but had steep slopes with palisades in front. The defence was stubborn, and the attack could only advance step by step. On 1st August two shafts were sunk, whence galleries were driven towards the salient. Efforts to reach these by countermining were unsuccessful, and on the night 7th August the mines were fired with good effect, and the craters occupied after a three hours' fight. No further advance could be made, and mining had again to be resorted to. This time the defenders were successful in countermining, and hindered the work considerably, only giving way on 18th August. On 24th the palisades of the covered way of the place itself were blown up, but attacks made on that and the following day failed, and Turenne's Army arrived in

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time to raise the siege. In this case the defenders advanced underground to meet the attackers as the ancients had done, and were undeterred by fear of explosions.

Military mines had now reached such importance that much controversy took place in regard to their construction and destruction. The ancients attacked the bases of the walls, but the advent of artillery led to the use of thick parapets of earth, which was obtained from a ditch, and galleries had to be inclined, or shafts sunk, to obtain the necessary depth. Wider and deeper ditches made the labour of driving galleries excessive. The failure of the first powder mines demonstrated the necessity of tamping the charge, and this led to placing the charge in returns, and not at the actual end of the gallery. Long vertical or stepped shafts with horizontal galleries from them were easier to construct than inclined galleries, but communication was more difficult.

Chevalier Antoine de Ville, an engineer born in Toulouse, now suggested sinking shafts in steps each the height of a man, from which it was more easy to remove the earth than from deep shafts. These shafts were sunk chequer-wise to facilitate tamping. Occasionally shafts were sunk in the ditch itself, or the ditch was crossed by blinded galleries. De Ville also indicated a method of defence by countermines; a shaft was sunk in the terreplein of the fortress whence a gallery was driven to beyond the counterscarp. At its extremity a transverse gallery was made embracing all ground likely to be threatened by the enemy's mines. From the transverse gallery shallow shafts were sunk, and branch galleries from these, which were in turn joined up by a second transverse gallery. De Ville unequivocally condemned the counterscarp galleries of the first French and Italian bastion systems, and to him therefore belongs the honour of having invented the system of modern countermining.

Candia, held by the Venetians, was besieged by the Turks from May, 1667, to September, 1669. The Turks could not isolate it from the sea, so that supplies were constantly pouring in. On the land side it was defended by a good seven-faced bastioned front, covered by exterior works which were countermined with a view to their destruction when they could no longer be held. Captain-General Morosini was in command, and this siege has made his name famous. The Turks opened parallels, and tried to make use of mines, but the defenders listening in their galleries always detected them, blew them up, or penetrating the galleries, damaged or carried off the powder. One of the outer works was captured by the Turks at the end of the fifth month of the siege, and after being recaptured, was finally abandoned and blown up with its Turkish occupants by a charge of 7,000 lbs. of powder. During the first six months 618 mines were fired, and the Turks acknowledged losing 12,000 men by that agency. A mine containing 18,000 lbs. powder is recorded, and during the year 1668 the defenders expended 3,000,000 lbs. of powder.

De Morosini had more faith in mines than in sorties, and the disastrous result of one sortie confirmed him in this opinion. In 1669 he determined to blow up the salient, which the Turks had captured, of one of his bastions. The explosion was of terrible effect, but the Turks returned

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to the attack, and on their part, succeeded in destroying the remainder of the bastion by a mine. This opened the place, and the end of its defence was at hand when a French division arrived as reinforcement. Morosini was unable to deter them from making a sortie, and they succeeded in driving the Turks from their trenches. Unfortunately at this moment a few barrels of powder left in a battery exploded. The French, who for the last two years had heard of nothing but the fatalities caused at Candia by mines, mistook this explosion for the bursting of a mine. Consternation seized commander and soldiers; the ranks broke and fled. The Turks pursued, but were checked by the fire of the garrison. It was, however, impossible to restore confidence, the remainder of the French troops departed by sea, the Germans followed, and Morosini, left to his own resources, was obliged to capitulate.

This deplorable event again draws attention to the moral effect of mines. Napier records that at the assault of Badajoz half a British regiment, which had escaladed the wall, fled in disorder at the sight of a lighted match on the ground, which had just been used to fire a gun. Prior to the assault of the Malakoff at Sebastopol, the Engineers fired several large mines on the glacis, which would certainly have destroyed any of the enemy's mines which had happened to be near, but were, in fact, only fired to inspire confidence in the attacking troops by showing them that their own troops were masters of the ground. Chevalier de Ville pointed out a means of locating the enemy's mines by the use of a boring tool. At Candia borers were used, and the miners placed small charges at the bottoms of the holes and fired them when they heard the enemy at work near by. This siege was therefore the first at which bored mines were used.

The French engineer Castellan, who was at Candia, returned to France after the siege, and was employed by Vauban to direct the mining operations at the Siege of Maestricht. He doubtless told Vauban how the Turks, against whom every inch of ground had been disputed, had multiplied their trenches and places of arms. Vauban had already published his *Première Instruction sur les Sièges*. At that time it was usual to open only one parallel, and in it, under the name of the Royal Battery, to place all the guns destined for the bombardment of the fortress. At Maestricht Vauban applied a new method of attack which he had deduced from the Siege of Candia, and opened several parallels.

A.R.R.

(*To be continued*).

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NOTICE OF MAGAZINE.

REVUE MILITAIRE SUISSE.

No. 3.—March, 1916.

THE ITALIAN ARMY.

Impressions from the Front.

The article on the above subject begun in the number of the *Revue* for February of this year (*vide R.E. Journal* for May, 1916) is concluded in the March number of the *Revue*.

IX. *The Artillery.*—In a campaign which has assumed, to such a great extent, the features of siege warfare artillery necessarily plays a very prominent *rôle*. The Italians have employed mountain artillery, supported by naval guns of the smaller types, in the mountain regions in which they are operating with some success against the enemy's camps, masses of troops and transport columns; but the mountain artillery has not been found to be effective against the enemy's entrenchments.

The Italian field artillery has proved to be excellent; at the beginning of the War it was armed largely with guns of Krupp manufacture; a few only of the artillery regiments were armed with the French Deport gun—an improvement on the now famous "75" mm. gun. It is the Deport gun which is most largely in use to-day.

Fortunately, the Italians had, prior to the outbreak of the War, provided their field army with heavy artillery. The lessons of the early phases of the War have not been lost sight of and, in consequence, great efforts have been made largely to increase the number of heavy guns in the Italian Field Army; guns intended for the coast defences have in some cases been diverted to the use of the Italian Field Army.

On the whole, the artillery has been well handled by the Italians and the Austrians have on several occasions suffered heavily from artillery fire owing to the skilful management of the Italian guns.

X. *The Engineers.*—The Italian Engineers have had some exceedingly tough work to perform in this war. Since the Italians invaded enemy territory at the very beginning of the War one of the first tasks which fell to the lot of the Engineers was the restoration of the communications at points where railway and road bridges had been destroyed by the retiring Austrians; they have acquitted themselves right well. In the mountain regions, new roads practicable for artillery have been constructed in an incredibly short space of time by the Engineers.

Owing to the great extent of front along which the Italian Army is operating—amounting to 310 miles—it became necessary at the beginning of the War, to increase very largely the engineer arm; for this reason whole battalions of infantry have been converted into battalions of engineers.

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XI. *The Cavalry.*—The present war has offered few opportunities for the cavalry to be employed on duties proper to that arm under normal conditions. Rather than wait idly for the day when conditions may again favour the employment of cavalry in its familiar *rôle*, officers, N.C.O.'s and men of the Italian Cavalry have sought transfer to other arms of the service, and, in consequence, large numbers of them have been transferred to the artillery, whilst others are now taking part in trench warfare as infantry.

XII. *The Officers.*—There are several military colleges for cadets in Italy, *e.g.*, at Pinerolo, Naples, Modena, Rome, Turin, Parma, etc., as well as schools for the technical branches of the Service and a War School at Turin. In Italy, as in other countries, candidates for staff employment are called upon to pass stiff examinations before their names can be placed on the approved list.

The courses of instruction in the military colleges and schools are based on the curricula which obtain in similar institutions in France and Germany.

XIII. *Discipline.*—The conditions which prevailed prior to the period when the several States, which now constitute United Italy, were welded into a single monarchy have left their trace on the Italian people; this consists in the marked individualistic tendencies shown by them. Nevertheless, in spite of this feature in the Italian temperament, thanks to the influence of the nationalistic policy which has been promoted by Italian statesmen, it has been possible to maintain a high state of discipline in the Army. A most excellent spirit obtains in the Italian Army and the relations existing between officers and men is all that could be desired, as is evidenced by the many deeds of self-sacrifice performed on the battlefield which have been recorded in connection with the lists of honours and rewards published from time to time.

XIV. *Conclusion.*—When the *Revue* article was written Italy had been at war for seven months; at that time vast reserves of *personnel* in the country had been left untouched and, except on the actual battle front, the civil population were carrying out their avocations almost in the same way as would have been the case under normal circumstances.

The present war has brought about that political union which the statesmen of Italy have been in search of during many decades past. Italians have flocked from all parts of the world to join the Italian armies operating on the Austrian frontiers with the object of realizing the ideals which the people of United Italy have been striving after, and for the first time in the history of this people is to be seen the spectacle of a national army sent forth to fight the battles of the country prepared beforehand in every way for the task assigned to it.

BELGIUM AND SWISS NEUTRALITY.

It is pointed out in an editorial note that the *Revue* article was written at a time when certain newspapers were calling attention to the fact that Belgium had not officially declared itself a party to the Pact of London, by which the Entente Powers had engaged themselves not to make peace separately with the Central European Powers; in consequence, it had been concluded that Belgium might possibly make a separate peace with Germany. The writer of the *Revue* article makes it

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clear that he personally did not consider the contingency of a separate peace on the part of Belgium probable; all doubts on the subject have now been set at rest by a recent declaration of Baron Beyens, the Belgian Foreign Minister, which amounts to an adhesion to the Pact of London. It is pointed out in the *Revue* article that Belgian honour has been too deeply wounded for the nation to accept lightly any peace offers which Germany may be willing to make; the government of Wilhelm II. has not yet been sufficiently humbled, it is thought, to induce it to offer anything more than the *statu quo ante* just now; at the same time it is recognized that the day may not be far distant when Germany will be glad enough to have one enemy the less and a frontier shorter by 90 miles to defend than that with which it is now concerned.

It is pointed out that it is not the probability of a separate peace between Belgium and the Central Powers which interests Switzerland most, but the effect such a peace is likely to have on Swiss neutrality and the independence of the Republic. The basis on which a separate peace might be concluded by Belgium is examined and for this purpose the history of this country is very briefly reviewed. It is pointed out that when the Belgian Provinces were under Austria in the XVII. and XVIII. centuries they constituted a more or less neutral buffer between Holland and France. After a short and troubled existence, from 1790 to 1795, as a Republic under the title of the United States of Belgium, this country—which then comprised more territory than it did in 1914—was annexed by France, in the year last mentioned. The next stage in its existence was as an integral part of Holland by virtue of the international agreement made at the Congress of Vienna. When the French sovereignty was put an end to a great part of Belgian territory, namely portions of the Departments of Luxemburg and the Lower Meuse, were acquired by Prussia and only what remained of Belgium thereafter was incorporated into Holland. The Belgian territory transferred to Prussia has for more than 100 years been in the nature of a Belgian "Alsace-Lorraine." The population of this territory is estimated at half a million and the majority of the inhabitants in this region, it is said, would welcome a return to Belgian rule. The surrender of this territory to Belgium would, it is thought, be pressed for by the Belgian Government in any peace negotiations with Germany. As Germany's military position would not be injuriously affected by acquiescing to such a demand, the reincorporation of this lost territory into a reconstituted Belgium may, it is suggested, well form a basis for peace negotiations. It is also pointed out that Belgium has never given up hope of some day re-acquiring the Grand Duchy of Luxemburg.

When the existence of Belgium as an independent kingdom was recognized by Austria, France, Great Britain, Prussia and Russia after the revolution of 1830, Holland obstinately refused to accept the situation, not only at that time but for some years after.

However, in 1839, on Belgium agreeing to allow Holland to retain, *inter alia*, Dutch Flanders, *i.e.*, the left bank of the Scheldt, west of Antwerp, the Grand Duchy of Luxemburg and the greater part of Limburg, including the fortress of Maestricht, Holland finally acquiesced

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in the independence of Belgium. Should Germany therefore desire to make peace with Belgium, it is expected that she might offer the latter the Grand Duchy of Luxemburg, since it now belongs to none of the European Powers, as well as the Rhenish territory formerly belonging to Belgium, since this forms but an infinitesimal part of German territory.

Although not strictly pertinent to the subject under discussion, the writer of the *Revue* article refers to the offer made by Belgium in 1863 to purchase from Holland the right to collect navigation tolls on the Scheldt, below Antwerp, for the sum of about 1½ millions sterling; previously to this Belgium had attempted to reacquire, on suitable terms. Limburg, Luxemburg, and the territory on the south bank of the Scheldt below Antwerp. At that time Holland would not entertain the foregoing proposals, but the whole situation has altered since then.

The writer of the *Revue* article recognizes that the conclusion of a separate peace by Belgium with Germany might not be looked upon favourably by the Quadruple-Entente Powers. However, he argues that since Belgium sacrificed herself in 1914 to save France, it would ill-become the latter country to oppose, at the present time, any action Belgium might take to obtain advantageous peace terms from Germany. Sight is not lost in the *Revue* article of the fact that if peace should be restored in Belgium the future neutrality of this country must be provided for on a more secure basis than was the case under the Treaty of 1831; *inter alia*, Belgium will require a frontier better capable of defence than her frontiers of 1914, as also a larger army. Further, it is suggested that Belgium herself will demand to be placed in the same position so far as her new neutrality rights are concerned as that occupied by Switzerland at the present time, *i.e.*, she will claim the *right to remain neutral* instead of having *the obligation imposed on her to remain neutral.*

The writer of the *Revue* article concludes that it would not be *impossible* immediately to secure the neutrality of Belgium on a broad basis and with added territory beyond her former frontiers subject, of course, to the assent of the other belligerent powers. "What would," it is asked, "be the consequences of such an event on the neutrality of Switzerland?" At present Switzerland is far removed from the regions in which the struggle in the western theatre has been most intense. The elimination of Belgium as a theatre of operations would, it is suggested, materially alter the situation so far as Switzerland is concerned. The German Army Corps released from the portion of the western front situated in Flanders, in Artois and in the Champagne would be set free for operations in other theatres. "Would these troops," it is asked, "be transported to Bagdad, Erzeroum or Salonica when it is on the cards that immediate and decisive results could be obtained by one side or the other in the present struggle making use of Swiss territory as a means of getting at his adversary?" The writer of the *Revue* article answers the latter question in the following terms:—"It is hardly probable; rather is it necessary to expect the contrary." He is clearly of opinion that a separate peace between Belgium and the Central European Powers cannot be looked upon as something favouring Swiss interests. He recommends the Swiss Foreign Office further to study the military situation.

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A Historical Point.

A difference of opinion exists between the writer of the article entitled "Independence and Neutrality" (reviewed in *R.E. Journal* for September and December, 1915) and a critic of Swiss nationality with reference to the behaviour of the Armies of the Directory which invaded Switzerland in 1798. This difference of opinion has given rise to a controversy which is published in the March number of the *Revue* under the above heading. This controversy is of little military interest in this country.

Some Reflections on Swiss Military Equitation.

The writer of the *Revue* article, who is a Swiss cavalry officer, states that instruction in riding and the breaking in of remounts are matters which, in his opinion, are not properly attended to in Switzerland; there is too much go-as-you-please in relation thereto. He urges, in consequence, that a school of equitation should be formed in Switzerland so that instruction in riding, breaking in of remounts, horse-mastership, and veterinary services may be centralized, and in order that uniformity of teaching and in practice may thus be gained.

How Can the German Front be Pierced?

The article on the above subject begun in the February number of the *Revue* (*vide R.E. Journal* for May, 1916) and is concluded in the number of the *Revue* under review.

The part of the article which appeared in the February number of the *Revue* concluded with a reference to the *rôle* played by the French artillery in preparing the way for the attack in an up-to-date battle. The part of the article under review opens with a reference to the *rôle* of infantry in carrying through an attack on the enemy's trenches. The important questions which arise in connection with the actual launching of the infantry for the attack are three in number:—

(*a*). How should the signal for the infantry to move forward for the attack be given?

(*b*). At what time should the signal be given?

(*c*). By whom should the signal be given?

As regards the first of these questions, it is suggested in the *Revue* article that it would be better for troops to act by the clock rather than that they should have to wait for a signal. In connection with the sieges of former times, the signal for the advance of the attacking troops at the opportune moment was, it is true, usually given either by the firing of an artillery salvo or of signal rockets. But in those days, the fronts held by the opposing sides were so narrow that the higher commanders could from personal observation form a more or less accurate opinion regarding the progress of events and decide whether or no the decisive moment had arrived for launching an attack. With the wide fronts held to-day it is impracticable, if not impossible, for the higher commanders to ascertain at first hand how matters may be shaping; under the circumstances, it is most difficult to give the signal for the attack at the psychological moment; it is as likely to be given too late or too early as at the decisive moment. It is recognized that serious consequences may follow in cases where the infantry is ordered to

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advance to the attack at a set time regardless of the actual situation. It is quite possible that the artillery bombardment may not have sufficiently paved the way to enable the infantry attack to be launched with any prospect of success; other circumstances, such for instance as fog, may intervene so as to prevent the infantry from moving. However, since the consequences likely to follow upon infantry being shelled by their own artillery must prove more disastrous than those to be anticipated in the case where columns of attack are late in making their forward move, it has become an established practice in the French Army to order the infantry attack to commence at a specified time.

Where the distance which must be covered by the attacking infantry to reach the enemy's trenches does not exceed 100 yards, the attack is delivered by successive "waves" of companies, the first of which is organized in two parts, thus:—

(1). A line of skirmishers at five paces interval, formed either by extending a complete section or by sending forward selected men from each of the sections of the company, in extended order.

(2). An "attacking line," 50 yards in rear of the skirmishers, consisting of a single rank of men, elbow to elbow, or at one pace interval.

It is unwise to count on surprising the enemy; and it would be equally foolish to assume that the attacking troops can be got to advance without replying to the fire with which they are likely to be met. The object of having a thin line of skirmishers, as above, is to afford some protection to the "attacking line," since the skirmishers can open fire on the enemy, whilst the closed rank in rear advances steadily forward without losing its alignment, and without firing until the enemy's trenches are carried.

Extracts are given in the *Revue* article from Capt. Laffargue's account of his experiences.

He states that at Neuville the first "wave" of the French infantry moved forward in the formation sketched out above; advancing at first at a steady marching pace, only when some 60 yards from the enemy's trenches did it break into a slow double. The "attacking line" maintained its alignment as if the men were on a peace parade. Considerable importance is attached by Capt. Laffargue to the maintenance of alignment on the part of attacking troops; he states that, in spite of the annihilating fire of machine guns, as he was leading the attack forward at Neuville, he could hear above the din of battle the "epic and splendid cry of supreme encouragement": "Alignez-vous! Alignez-vous!" which rang out along the rank behind him. He further states: "The advancing wall-like line proved irresistible."

Capt. Laffargue objects to the term "reinforcements" being applied to the second "wave," since the merging of the second "wave" into the first "wave" is in no way contemplated. On the contrary, it is expected that the first "wave" will, as a rule, have expended itself in the early phase of the infantry attack, and consequently fresh troops will have to be substituted for the men composing it. The second "wave" should, as far as possible, avoid the zones in which the enemy's

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fire has proved most destructive to the first "wave," and should be pushed into the attack along the portions of front in which the enemy's resistance has perceptibly weakened. When the second "wave" has succeeded in gaining a footing in the enemy's advance trenches, it should at once be re-formed and then pushed forward to the enemy's second line of trenches. The enemy, when driven eventually from portions of the second-line trenches assaulted, is generally able to continue in possession of the "centres of resistance" prepared in rear of the first line of trenches and thus can prevent the second "wave" from extending outwards.

It is suggested that in many cases the functions of the second "wave" have not been clearly understood by responsible commanders. Instead of looking upon it as a second line of attack, with a task similar to that of the first "wave," destined to replace it and to continue the action by advancing against definite objectives assigned to the second "wave," commanders have, too often, confined themselves to the utilization of the second "wave" for the purpose of reinforcing the first "wave" at points where it appeared to have been weakened and to need support. Another error made by commanders is that they have frequently lost sight of the fact that since the troops destined to form the second "wave" themselves come under the artillery and rifle fire directed against the first "wave" these troops should consist of specially picked men; by reason of this oversight, less reliable troops have often been employed in the second "wave" than in the first "wave," with the consequence that the attack has come to a dead stop before attaining its objective.

The above criticism may perhaps be correct; nevertheless the question arises whether after all the best troops should not be used to break a passage through the enemy's trenches for the troops which follow and also in order to set them an example to be imitated.

A short description is given in the *Revue* article of the preparations usually made in connection with the launching of the second "wave." It is stated that the troops to be employed in the second "wave" are pushed forward as near to the first-line trenches as possible and held in readiness in the sidings in the communication trenches. In cases where the opposing first-line trenches are very close together, the nearer the troops for the second "wave" are to the fire trenches the less are these troops likely to suffer from the enemy's artillery fire. As soon as the whole of the first "wave" has been launched, the troops for the second "wave" at once occupy the vacated first-line trenches. Although no long interval of time should be allowed to elapse between the launching of the first and second "waves," yet it is essential that the effort of each of these "waves" should be kept entirely distinct. The second "wave" should, therefore, be launched when the first "wave" is on the point of penetrating the first zone of the enemy's defences. The troops forming the second "wave," having deployed in the first-line trenches, are sent forward simultaneously against objectives which should be definitely assigned to them, *i.e.*, it should be clearly stated that—

(*a*). The zone between named points must be seized.

(*b*). The outlying parts of a definite "centre of resistance" must be seized.

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Each company composing the second "wave" should advance in two parallel ranks, separated from one another by about 150 yards, the first rank being extended at three to four paces intervals. The company commander should place himself between the two ranks so as to exercise supervision over his command till the last moment.

Capt. Laffargue suggests two methods of delivering the infantry attack; namely, one method for the case where the elements of the first line brought to a halt are separated from the enemy's line of resistance by a distance of less than 200 yards, and the other where this distance is greater than 200 yards.

In the first of the above cases if the first line, when brought to a standstill, is able to hold on to the ground gained by it, the position reached by it becomes a sort of parallel from which the troops forming the second "wave" can be launched. In the case in which the distance to be covered to reach the enemy's trenches exceeds 200 yards, some suitable intermediate position, about 100 yards from the enemy's position, should be selected and occupied as a parallel with the deliberate object of launching the second "wave" of attack therefrom. If such a *parallèle de départ* exists naturally, well and good; if it does not exist, then one must be created, even if delay is caused thereby.

Other "waves" follow the second "wave"; whether these be the second, third or fourth "wave," each and all of them follow and conform to the movements of the first "wave." Thus it is that finally the end in view will be gained and the enemy's line pierced.

The writer of the *Revue* article suggests that Capt. Laffargue's reflections and advice may possess a greater literary than a military value; however, in this matter everyone can form his own opinions after reading what Capt. Laffargue has to say on the subject.

NOTES AND NEWS.

Switzerland.—In the previous issue of the *Revue* the French-Swiss view in relation to the Swiss General Staff Scandal was placed before the readers of this publication; in the current issue of the *Revue* is set out what is intended to be the German-Swiss view on the same subject.

The contributor of this *Revue* article begins by suggesting that an error was committed in high quarters. The competent authorities were inexplicably slow in taking action in the matter, and this has led to a weakening of confidence in the Government on the part of some people, though the majority of the Swiss nation have, it is stated, remained unmoved.

It is urged that the Commander-in-Chief of the Army and the Chief of Staff constitute, so far as soldiers are concerned, parts of the State organization in which the most implicit confidence must be placed, irrespective of any views which may prevail regarding either the personality of the holders of these offices or acts for which they may be responsible, since military discipline and loyalty to the flag impose an obligation on soldiers to follow them and to execute their orders without any reserve.

The "affair of the General Staff" is represented by the contributor of the *Revue* article to have been given a political colour by certain extremists who, although claiming to be patriots, are not really Swiss at

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heart. He considers that there is no justification for attributing German sympathies to the Swiss General Staff; it is claimed that, on the contrary, those holding the highest rank in the Swiss Army as well as those holding the lowest rank have, during the present war, as completely fulfilled their duties as Swiss citizens as any other part of the civil population.

It is suggested that public opinion is swayed by foreign influences, but the Army is unmoved by such influences which, if they could find a responsive chord therein, would end by completely destroying the strength of the nation. But the fact remains that the Swiss nation continues to live and Swiss troops still maintain the right spirit. The contributor of the *Revue* article concludes by stating that he has forgotten which point of view he had undertaken to defend, the French-Swiss or the German-Swiss; but this matters not, as his views are those of a Swiss soldier.

Portugal.—A special correspondent draws attention to the fact that two decrees of considerable importance to the Portuguese Army were promulgated in 1915; one of them dealt with the organization of a military mechanical transport service, and the other with regulations relating to the Military School of Aeronautics. A matter of general interest from the point of view of national defence is the bill dealing with the mobilization of industrial resources laid before the Portuguese legislature in December last.

The Minister for War has recently appointed a Committee on military mechanical transport (attached to the General Staff); further, two Schools of Instruction in Mechanical Transport have been created by him.

The Committee referred to consists of five members, one being a civilian, and is concerned with:—

(*a*). The preparation of designs for the construction of motor vehicles suitable for military purposes.

(*b*). The inspection of existing motor vehicles in the country and their classification with a view to employment for military purposes.

(*c*). The improving of the organization of the motor-vehicle service and the developing of mechanical transport in Portugal generally with a view to military needs.

The Schools of Instruction in Mechanical Transport are concerned with:—

(i.). The training of officers, N.C.O.'s and men in the driving of motor vehicles, and in the maintenance and execution of repairs thereto.

(ii.). The furnishing of *personnel* to the mechanical transport service, the custody and care of motor vehicles and the distribution of the same to the various formations of the Army.

Details are given of the courses of instruction at the Military School of Aeronautics.

The Portuguese Government, as a first step towards the mobilization of the industries of the country for war purposes, has taken over all chemical factories which were unable to procure the raw materials

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required to keep them going. These factories are now in charge of technical experts appointed by the Government and are producing materials necessary for the Army and also for agricultural purposes.

INFORMATION.

Switzerland.—Colonel Feyler contributes an article to the March number of the *Revue* on "the Swiss Crisis." He deals with the subject in two acts:—(i.) The trial of the two colonels of the General Staff before a Military Tribunal and (ii.) the session of the Federal Chamber.

The trial, he states, has helped to calm the public rather by reason of the manner in which it was conducted than by reason of the verdict and the judgment given. The Tribunal has found that a violation of neutrality was committed by the accused colonels brought before it.

The accused colonels were found to have acted under the orders of the Chief of the General Staff and, therefore, they were acting in good faith which mitigates their offence. It is pointed out that, nevertheless, their conduct does not tally with the policy laid down by the Federal Council and, therefore, must be condemned.

The conceptions of their obligation in relation to their military duty held by Colonel Sprecher, the Chief of the General Staff, and his subordinate, Colonel Egli—one of the accused—as disclosed by their evidence, largely account, it is said, for the unfortunate situation which has arisen.

Closely associated with the "Crisis" are the campaigns which preceded the reforms introduced by the Military Laws of 1907 and of 1911, campaigns which were really duels between Colonel Wille and Colonel Sprecher and therefore created a most unedifying situation. This situation has in no small measure contributed to bring about the crisis which has resulted in the two colonels of the General Staff being brought to trial.

In relation to the second act it is stated that the debates in the Chamber had not terminated at the time of going to press, but so far as they have gone:—

(*a*). It is evident that the views expressed in the debates are very different from those which prevailed in the Chamber a few months back.

(*b*). It is clear that the Swiss cannot be forced along paths which do not lead in the direction they wish to travel.

(*c*). By reason of the criticisms in the Chamber some diminution in the plenary powers conferred on the military authorities in the early days of the War has been brought about, and the control of the Legislature has been to some extent re-established.

It is said that order reigns once more in the Army and it is, therefore, now proposed to close the correspondence relating to the Espionage Scandal.

Indirect Fire from the Trenches.—A brief reference is made to a periscopic rifle sight which the Germans are said to have provided for the use of their infantry. It is claimed that a 20-fold magnification of the object aimed at is obtained by the use of these sights, which consist of a simple arrangement of a mirror: these sights are extremely light and portable.

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